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FOULING THE SEAS

THE Minister of Transport appointed a committee of representatives of British shipping, oil companies, dock, harbour and transport authorities and interested Government departments in September 1952, to consider and report upon practical measures to prevent oil pollution. In less than a year, a very informative report was prepared and published*, giving a clear picture of the shocking amount of pollution. The sources are examined in great detail and a long-term policy of introducing effective preventative measures is advocated. As an interim measure, immediate action is recommended prohibiting ships registered in the United Kingdom from fouling the neighbouring seas and shores. The subject was discussed at a full-day meeting in London of interested bodies on October 27 (see p. 1025).

The fouling of the seas, hundreds of miles away, damages the fauna and flora of seas and coastline, and spoils the amenities of sea-shores. The evidence is that oils causing the worst pollution are very stable; there may be slow oxidation, so slow as almost to defy detection, but these oils keep floating almost indefinitely. Oil on water in experimental tanks remained for nearly eighteen months, until the water had disappeared through seepage and evaporation. In the late summer of 1952, British oil companies carried out experiments on the behaviour and drift of oil discharged on the sea. Fifteen tons of fuel oil covered an area of eight square miles six days after discharge, and in eight days had drifted some twenty miles from the point of discharge. The proposed prohibition of discharge of oil within a prescribed zone is only a palliative, but would be a first step towards international agreement to prohibit any fouling of the seas with oil. Further experiments are being conducted with drift cards to obtain more information of the drift under the combined influences of winds and tides. The winds greatly influence drift; it is those shores exposed to the prevailing winds that are the most polluted.

Perhaps one of the most important recommendations is that the various possibilities of chemical treatment as a means of preventing pollution should be explored, and a programme of research ought to be sponsored by the Government at the earliest opportunity.

The sources of pollution have been very thoroughly investigated by the committee; analyses were made of samples of oil found on the beaches and on the plumage of sea birds, and almost without exception they had the characteristics of crude oil residue or fuel oil. One source of oil pollution is not mentioned in the report, namely, the escape of unburnt fuel through the funnels of oil-burning ships. Unburnt fuel, although only one or two per cent of the fuel consumed, may be deposited on the sea and the effect of this should also be investigated, because it is the more deleterious compounds that escape, and even one per cent of the bunker fuel is a very large tonnage each year.

* Ministry of Transport. Committee on the Prevention of Pollution of the Sea by Oil. Pp. v+50. (London: H.M. Stationery Office, 1953.) 2*s*. net.

Although the committee was not asked to study the damage caused by oil pollution, the ill-effects indicated in the report are: (*a*) the spoiling of beaches and the amenities of coastal resorts; (*b*) the destruction and injury of sea birds; (*c*) the fouling of boats, fishing gear, quays, etc.; (*d*) risk of fire in harbours and other enclosed waters.

The oil is also deleterious to marine flora, and the widespread disappearance during the past twenty-five years of the eel-grass *Zostera marina*, a plant of the inter-tidal zone, is believed by some to have been mainly brought about by oil pollution. The symptoms of the disease of this plant, including the final stage in which it is killed by a parasite, *Labrynthula*, are very similar to the symptoms observed on similar land plants when oil is used as the killing agent. The large areas of eel-grass provided a special habitat for fish and food for wildfowl, and the long fronds were effective breakwaters. Where large areas of eel-grass disappeared there has been a decrease in molluscs and crustaceans, wildfowl have moved elsewhere, and erosion of the coastline has often followed. The conclusions are that waste oil not only fouls, but also kills, and that the cost of the present scale of pollution of the seas of the world is such that vigorous action must be taken at once to halt this menace; and then, as quickly as practicable, on an international basis, to eradicate the sources of oil pollution of the seas.

The highest praise is due to the committee for the presentation of this excellent report within so short a time, and it is hoped that prompt action by the Government will follow, thus giving a lead to other countries on essential standards of cleanliness.

THE INTERACTION OF SCIENCE AND SOCIETY

In recent years, many papers and books surveying the impact of science on society and the influence of the modern democratic State on the progress of science have been published. Some have been confined to a narrow field of interest, whereas others have attempted a survey of the whole broad problem. A recent book on this subject is Mr. Bernard Barber's "Science and the Social Order"*; although this refers particularly to the American scene, its general conclusions are worth consideration in a wider context.

In his view of the nature of science, Mr. Barber follows Dr. J. B. Conant, whom he quotes extensively, adopting a matter-of-fact and realistic treatment which is a valuable feature of his book. He shows both the reason why science alone can never provide for man a complete adjustment to the natural and social world, and also the way in which the good conceptual schemes, which Dr. Conant regards as the essential component of all science, are interwoven with controlled experimentation in scientific advance. A clear understanding of this relation is, as he rightly insists, of great importance in considering the possibilities and technique of scientific advance, especially in the social and biological fields. It is of the greater importance because modern man has to learn not only about, but also to live with, science.

The relation between the conceptual schemes of science and the body of belief and knowledge usually termed 'common sense' is an aspect of the nature of science which is discussed more fully in his review of the development of science. Here he stresses some conceptions which he regards as essential for understanding the social aspects of science: the universality of human rationality; the continuity of the evolution of science; the importance of some social influences, including the economic factor, on the development of science; the relative autonomy of science, considered as a component of society; and the reciprocality of influence between science and the other components of society. Generally, he follows Whitehead and rejects the Marxist view that science is a wholly dependent part of society, moulded fundamentally by the economic factor; he holds that science has a reciprocal influence on the other sectors of society, and thus makes his examination of the characteristics of modern society which are favourable to the development of science more realistic. Incidentally, he brings out the significance of Sir Edward Appleton's recent plea for the pursuit of science for its own sake.

Mr. Barber believes both that only in certain types of society can science flourish, and that without a continuous and healthy development and application of science such a society cannot function properly. Discountenancing extreme statements regarding the effect of political ideology on scientific work, his general discussion of the social organization of science and the affinity between the accepted values of science or the characteristics of the scientific attitude and those of liberal societies is a wholesome corrective to some current polemics. Science, he points out, has its moral values, as well as its conceptual schemes. 'Pure' science is concerned primarily and immediately with the development of conceptual schemes, and applied science with making such schemes instruments to some purpose other than the pursuit of conceptual schemes for their own sake. The moral values of science are also involved, however, just as they are in the motivation of individual scientists, which may determine whether they adopt a career in science or in technology; and although in technology rationality may have a higher limit, other values cannot be disregarded even there.

While Mr. Barber's discussion of the role of the scientific and professional societies and their interrelations is primarily concerned with conditions in the United States, his observations frequently have a much wider bearing and are highly relevant in considering the future of professional organizations and of scientific societies in Great Britain. The

* Science and the Social Order. By Bernard Barber. Pp. vii+288. London: George Allen and Unwin, Ltd., 1953.) 20*s.* net.

social pattern may differ; but the real problems are essentially the same, though the relative importance of particular factors may vary considerably. For example, the comparatively low prestige of all Government employment in the United States has depressed the public prestige of Government scientific research in that country, with an effect on recruitment the reverse of that which has existed in Great Britain, at least until recently.

In recognizing the interaction of science and society, Mr. Barber discounts any attempt to exaggerate the influence of social conditions on invention or discovery, and he dismisses the allegation that inventions are suppressed for narrow or selfish interests. His discussion of the technological change is, however, brief and stimulating rather than penetrating; and here again he insists on the importance of regarding all the moral values within the context of which science functions. He gives a timely warning against the danger of two extremist positions in accepting any kind of social responsibility of science: acceptance of exclusive responsibility is as dangerous as the 'ivory tower' attitude with its rejection of all responsibility for the social consequences of scientific discoveries. His discussion of what are often called the social responsibilities of science is realistic; for it is clearly impossible to predict the long-term social consequences of a particular discovery, or to dogmatize on the continuous interaction of social factors and science.

The great need, as Mr. Barber sees it, is for more understanding between the physical scientist and the social scientist. Science, he holds, has the obligation to extend its method to the study of the social and political process itself; and further, he makes the point that the social and natural sciences are not so completely separable from one another as is commonly assumed. Even the protagonists of the wholesale planning of science and those of freedom in general differ less than they think, and Mr. Barber remarks with some truth that they could probably collaborate very profitably in the kind of concrete prediction and formulation of programmes that occur daily in science. More of the method of science itself is, in fact, required at exactly this point.

Mr. Barber's critical analysis of the nature and prospects of the social sciences is the more persuasive because of its realism. He never claims too much, and he gives due weight alike to the rationality in society which gives social science its freedom to investigate rationally the very fundamentals of society, to the high degree of indeterminacy in most of the information classed as social science and to the non-rational elements in human life which are no more entirely ignorance and error than that the non-empirical elements are all 'unreal'. Natural science, he reminds us, has not yet given, and never will give, us complete control of the physical and biological universe in which we live. Knowledge does not need to be complete to be effective, and because human knowledge is only one of the factors that determine social behaviour its influence is for that reason limited; we need not fear that social science will create the possibility of complete social control. On the contrary he believes that, just as natural science has been used to give us relative abundance, social science can be used to give us freedom in the same relative measure; nor will science in our present society achieve maturity until social science comes of age with the natural sciences. One of the best auguries of that may well be the increasing awareness among social scientists of the nature of the scientific task which confronts them. Mr. Barber suggests, in conclusion, that in this twentieth century we may see the emergence of the conception of an 'order of human nature', with a fructifying influence on the development of social science comparable with that which the conception of an 'order of nature' has had on the development of natural science since the seventeenth century. His book provides evidence that this optimism is at least reasonable; the arguments merit careful study and discussion.

STUDIES IN ANTHROPOLOGY

Anthropology Today

An Encyclopedic Inventory. Prepared under the chairmanship of A. L. Kroeber. Pp. xv+966. (Chicago: University of Chicago Press; London: Cambridge University Press, 1953.) 67*s.* 6*d.* net.

THE occasion for this collection of studies on the various fields of anthropology was the organization of an international discussion conference in New York last year by the Wenner-Gren Foundation for Anthropological Research in celebration of its tenth anniversary. The authors are mostly, but by no means exclusively, American, and their contributions were prepared and distributed in advance among the members of the conference, both to provide points of departure of a series of discussions and an inventory of outstanding recent advances in anthropology. It should be noted that a detailed and lively report on the views developed during the conference itself has also been published as "An Appraisal of Anthropology Today" (Tax, S., *et al.*, editors. Chic. Univ. Press, 1953).

Owing largely, it would appear, to the traditions and circumstances of university teaching and research there, the interconnexions between the various branches of anthropology have been more effectively maintained in the United States than in Britain and the rest of Europe. This is reflected in both the wide coverage and the conscious efforts at integration which are apparent in this inventory. Thus, the papers variously devoted to aspects of human evolution, to the long-term culture history of the major regions of the world, to analyses of cultural processes and the range of factors underlying cultural variation and development show, for the most part, an awareness of problems, methods and findings in other fields. On the other hand, it can scarcely be claimed that either in coverage or arrangement this series of some fifty papers affords as well-organized and encyclopædic a view of approaches and results as could be desired. Practical and human limitations no doubt account in part for omission and defects, but the grouping of the papers into three main sections labelled "Problems of the Historical Approach", "Problems of Process" and "Problems

of Application" is not consistent and fails to bring out significant distinctions among the data and problems of modern anthropology. In this way, Prof. Steward's valuable paper on "Cultural Evolution and Process" is placed under the "Historical Approach", while many of the papers listed under "Process" are, in fact, concerned with field-techniques and methodology. Nor do headings of subsections labelled "Method", "Results" and "Theory" fulfil their promise. More seriously, since the main objective of the conference, as expressed by its chairman, Prof. A. L. Kroeber, the doyen of American anthropology, was to secure the "advantage to be gained from a gathering that would envisage the field as a whole with the intent of pulling together what belongs together", and was to promote the cross-fertilization and integration of anthropological studies, there is little attempt to compare the *raison d'être* of the various approaches and formulate the real possibilities and conditions of their synthesis.

Some aspects of the fundamental distinction between historical and analytical studies in the various fields, which account for differences in the selection and handling of both biological and cultural data, are well sketched by R. Redfield in "The Relation of Anthropology to the Social Sciences and to the Humanities". But the equally important interdependence of historical and analytical studies, and the extent to which the degree of integration achieved in the descriptive studies depends on achievements in the analysis of socio-cultural processes, does not receive adequate attention. Analysis of the important distinction between the cultural and the sociological levels of analysis, on which there is a confusion that leads to misunderstanding and misdirection of effort in both field-work and theoretical studies, is also lacking. The unfortunate cleavage between ethnography and sociology that developed in American academic studies and is only slowly being remedied by the widening of anthropological and sociological theory there, accounts perhaps for the inadequate space (a single stimulating, but almost entirely methodological paper by C. Lévi-Strauss) given to the comparative study of social systems which has been so prominent in recent British anthropology.

But while omissions, some lack of balance and loss of opportunities may be regretted, this volume does include a number of admirable surveys of the achievements and trends in several branches of anthropology that are at once authoritative and critical. On evolution and variation in man there are useful studies on "Primates" (W. J. Strauss), "Race" (H. V. Vallois), "Evolution" (G. S. Carter) and "Methodology" (S. L. Washburn). Present knowledge of Old World culture history has been most competently summarized, and some of the implications concerning basic processes in cultural and social development analysed, in a series of papers by H. L. Movius, V. Gordon Childe and J. G. D. Clark. A similar conspectus is provided for the New World by Wendell Bennett, G. Caso, A. D. Krieger, Irving Rouse and G. Willey. Various anthropological approaches in linguistics are well reviewed by J. H. Greenberg, F. G. Lounsbury and A. Martinet. Several aspects of the study of the socio-cultural patterning of personality and of ethical and æsthetic values are analysed by A. I. Hallowell, Margaret Mead, F. S. C. Northrop, D. Bidney and M. Schapiro; while the application of anthropology in various fields such as medicine, industry and Colonial administration is reviewed by J. M. Tanner, Eliot Chapple, Daryll Forde and others. In all, this volume of nearly a thousand pages provides a useful guide to the approaches, problems and results in the many active fields of anthropological research. The studies for the most part maintain a high standard of clarity in exposition which will enhance their usefulness to scholars in other fields, as well as to students of anthropology. It is perhaps useful to note that the work can be obtained on special terms through membership of the American Anthropological Association.

DARYLL FORDE

BIRD STUDIES

Rare and Extinct Birds of Britain

By Ralph Whitlock. Pp. 224+85 plates. (London: Phoenix House, Ltd., 1953.) 21*s*. net.

THE title of this book is somewhat misleading since many of the birds referred to can scarcely be considered rare, though they are not generally distributed owing to their particular habitats. "Lost Breeding Species" is the heading of the first chapter, and it seems a trifle unnecessary to include here the pelican, of which there is no historical evidence that it ever bred in Great Britain. Among the other species mentioned in this chapter are the crane and the spoonbill, and also the sea eagle and osprey. So far as is known, the first two never nested in any great numbers in Britain, and since they were both esteemed as food they suffered accordingly and ceased to nest long before their feeding grounds had been seriously affected by draining. The case of the sea eagle and osprey is somewhat different, and their extermination as breeding species is a sorry story. In Scotland at least, they suffered from the opening up of the Highlands to sheep-farming and sport—grouse shooting and salmon fishing. The eagle did little harm to grouse; but it was a bird of prey and that was enough. Furthermore, it was fond of young lambs, and so, in addition to the game-keeper, the hand of the shepherd was against it; also the eggs always obtained a ready market. Charles St. John has been blamed for the extermination of the osprey in the north of Scotland; but he was not the only one who shot the nesting birds, and moreover the slaughter of Scottish ospreys in England on migration probably did much to reduce the breeding stock. Unfortunately the osprey lays a very beautiful egg, for which a good price was readily given.

The next chapter deals with "Rare and Local Nesting Species", which is more pleasant reading since a number of the birds referred to have increased (as, for example, the raven, golden eagle and bittern), the avocet has come back to nest in East Anglia, and the little ringed plover is colonizing in Britain. On the debit side the numbers of breeding corncrakes and wrynecks have greatly diminished. Agricultural changes are blamed for the decrease of the corncrake, but no one has yet explained the cause of scarcity of the cuckoo's mate. Surely the fulmar can scarcely be described as a rare or local breeding species at the present time. Dumfriesshire was the great stronghold of the black game, and it is very doubtful if the decrease had anything to do with "the growth of the human population" as the author suggests. It is quite true that draining and other agricultural changes have lessened their haunts; but before these changes had taken place the numbers were in decline.

The author is unfortunate in his quotations from F. O. Morris's book on British birds, and in this connexion it may be mentioned that the dotterel never bred in East Lothian, where there are no hills high enough, though large numbers were shot during the spring migration in the middle of the past century.

Chapters are devoted to "Continental and Allied Subspecies", "Rare Birds of Passage and Seasonal Visitors and Vagrants", and what the author calls "Eccentricities", by which he means birds that have occasionally appeared in Britain far out of their normal range. Much has been learned of late about some of the birds in the above categories from the work carried out at the trapping stations on the coast. But a word of warning is necessary in regard to the identification of rare warblers, especially those belonging to the genus *Phylloscopus*. The late Dr. C. B. Ticehurst informed the reviewer that, when he was engaged in preparing his monograph on that genus, he examined collections from all the leading museums of the world and in several instances found different ornithologists had identified the same bird-skin as belonging to a different race and even to a different species!

In the final chapter there are remarks on the effect of the changes of climate and the increase of certain birds' breeding range.

In the preparation of this work the author must have been handicapped in not having a comprehensive ornithological library at his disposal; but nevertheless he has produced a volume which will be of interest to many. The book is illustrated with more than eighty photographs of birds, all of which are of exceptional merit. N. B. KINNEAR

A STATISTICAL STUDY OF THE STELLAR SYSTEM

Statistical Astronomy

By Robert J. Trumpler and Harold F. Weaver. Pp. xxi+644. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1953.) 7.50 dollars.

JUST half a century ago, Kapteyn propounded his famous theory of the two star-streams, based on an analysis of the available material relating to proper motions—the angular motions transverse to the line of sight. The theory was later developed, notably by Eddington, and these early researches form the true beginning of the modern study of the Galaxy. An alternative method of representing the systematic motions of the stars was afterwards suggested by Schwarzschild; this is known as the ellipsoidal theory, the frequency function of the linear components of stellar velocities (freed from the solar motion) being expressed in terms of a quadratic function of ellipsoidal form. A substantial part of the book is devoted to the statistical study of these two ways of describing systematic motions. In more recent times the observational astronomer has considerably increased the numerical data available for the statistician, these including radial velocities, parallaxes, apparent magnitudes and spectral types, in addition to proper motions.

Rather more than one-third of this monumental book of 644 pages (Part 1) is devoted to the general theory of statistics, with applications to many astronomical researches. This part is written with due consideration of fundamental principles and forms a fitting introduction for the professional statistician to some of the important problems with which the astronomer is confronted. Included in this part is a valuable chapter on the integral equations arising in astronomy, with sections on the solution of Volterra's equation of the first kind, and solutions by Fourier transforms, by interpolation functions or series, and by numerical integration. This part concludes with an interesting and important chapter on the testing of hypotheses, contributed by Dr. Elizabeth Scott.

A short part (2) gives a statistical description of the galactic system, the complete account of which is expressed in terms, substantially, of six variables—the three linear components of stellar velocity, parallax, absolute magnitude and spectral type.

Part 3 deals with stellar motions in the neighbourhood of the sun. The two-streams hypothesis and the ellipsoidal hypothesis are examined by the methods of Part 1 with reference to the observational material provided by proper motions and radial velocities in the first instance, and to the space-velocities of stars with measured parallaxes. Despite the relatively high errors in parallaxes, the authors appear to lay considerable emphasis on past investigations based on space-velocities. The theoretical researches of Eddington and Schwarzschild have, regrettably, no place in the book, and it may be that the mechanical methods of the statistician will not commend themselves fully to the astronomer long familiar with the mathematical elegance and descriptive insight of the classical investigations.

Part 4 gives a full and excellent account of the problems associated with the relations between luminosity and spectral type. In Part 5 the space-distribution of the stars is treated authoritatively and at considerable length, with emphasis on the extinction of light in interstellar space; this part will prove of great value in current investigations on the spatial and physical properties of the interstellar clouds.

The final part is concerned with the theory of galactic rotation treated mainly on familiar lines, with a critical discussion of some discrepancies between theory and observation.

The volume ought to prove a very welcome addition to the literature on the galactic system, the copious bibliography appended to the several parts being specially valuable. The authors are to be heartily congratulated on producing a work of such immense range. W. M. SMART

FINE PARTICLES AND STATISTICS

Small Particle Statistics

An Account of Statistical Methods for the Investigation of Finely Divided Materials. By Dr. G. Herdan; with a Guide to the Experimental Design of Particle Size Determinations, by Dr. M. L. Smith. Pp. xxiii+520. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1953.) 70*s*.

STATISTICAL principles and methods found their first practical application in the biological, social and economic sciences. More recently the applied physical sciences have recognized the value of planned experimentation and statistical analysis. But this development has been hampered by the strong

biological flavour of statistical text-books and by university syllabuses which produce statisticians more familiar with problems drawn from anthropometry or psychology than from, for example, chemical engineering. There is need for statistical treatment of physical, chemical and technological subjects. It requires a considerable mental effort to sustain the translation of bushels of wheat, girth of school-children or cost-of-living indexes into volumes, lengths and reaction-rates; the popularity of Brownlee's short monograph on "Industrial Experimentation" is due, one suspects, as much to its use of examples from the chemical industry as to its readable presentation of statistical methods. But it is not simply a matter of translation from one technical language to another. Apart from changes in emphasis, different statistical procedures being more important in one field of study than another, the proper choice of statistical method and the correct interpretation of statistical analysis require a close collaboration between statistician and physicist or chemist.

A statistical treatment of the subject of fine particles and granular materials, such as Dr. G. Herdan has undertaken in "Small Particle Statistics", is therefore most welcome. The only previous work with a statistical approach is Krumbein and Pettijohn's "Manual of Sedimentary Petrography"—an admirable account up to 1938, but limited to petrographical aspects and now out of date. Dr. Herdan's book covers more ground but is restricted mainly to physical processes.

The field of particle physics is especially in need of such text-books. Statistical methods are obviously important where the first step in any investigation is to take a sample of the powder or granular material; yet few workers report even the standard error of replicate measurements. A more important reason is that the mathematics of particle physics rests on the mathematics of statistics: both are concerned with frequency distributions. Dr. Herdan wants to go further: his object is "to establish the statistics of particles in the sieve and sub-sieve range as a branch of statistics, theory and practice, in its own right". This is a matter of point of view. Most people will think of the study of small particles as a branch of physics (and physical chemistry), in which much use is made of the mathematical procedures of statistics.

The author himself implicitly took the latter attitude when planning his book. He rejected the course of setting out the relevant statistical techniques and illustrating them by examples from particle physics. Instead, the framework of the book is based on the physical processes. The twenty-two chapters are grouped into five parts, the first three dealing with particle size analysis (Part 1), size-dependent properties of powders (Part 2), and size reduction, flocculation and mixing (Part 3). The statistical material is given chiefly in a block of chapters (6–10) linking Parts 1 and 2, but is further amplified in Part 4. The last part (5), written by Dr. M. L. Smith, is, in spite of its title "Experimental Design and Experimental Errors of Particle Size Determination", largely repetitive of material in Part 1, without the algebra, expanded by advice on experimental technique.

This approach was designed to meet the needs of the reader who has no knowledge of either particles or statistics; but to succeed it must have an adequate treatment of the physics of particles combined with a carefully planned presentation that avoids excessive repetition or cross-referencing. The author has not avoided these pitfalls. The impression is given that he never quite reconciled himself to a main theme of particles rather than of statistics.

Throughout the book, the discussion of particle physics, and its relevant algebra, lacks firmness; much is, in fact, a précis of published papers. There is little uniformity of treatment, the graphical or algebraic derivations of the original papers often being retained with little regard for style or conciseness. The reader is not sufficiently warned of the inadequacies of the elementary physics of processes such as sedimentation, light scattering and permeability. An insufficiently critical approach is shown also in some discussions on properly statistical questions: for example, Martin's statistical diameter (p. 67) is not the same as the mean chord, nor is equation 5.1 correct; the mean projected area (p. 95) is equal to a quarter of the surface area only for convex bodies; the light extinction method (pp. 30, 95) does not yield a distribution by surface area as defined in Chapter 4.

Nevertheless, there are many good points. The newcomer to the subject is well warned of the need for a statistical approach and will be struck by the power of statistical analysis as shown in copious examples, calculated in many cases from published, but not previously analysed, data. Those more familiar with the subject will discover many interesting and stimulating ideas, especially in the use of inequalities (Chapters 4, 15 and 16) between means and higher moments of differently weighted size-distributions as measures of spread. All will welcome the accumulation in one volume of a diversity of material.

P. G. W. Hawksley

ANCIENT AND MEDIEVAL SCIENCE IN ASIA

Eastern Science

An Outline of its Scope and Contribution. By Dr. H. J. J. Winter. (Wisdom of the East Series.) Pp. vii+114. (London: John Murray, 1952.) 4*s*. 6*d*. net.

THIS is a book small in size, but great in its conception and greatly needed. It is the first attempt ever made to set forth, in a form available for the general reader interested in the history of science, the ancient and medieval contributions of the countries of Asia. In our own time it has become an urgent necessity to correct that distorted perspective, still entertained by most Europeans, that all technology arose solely from western Europe and that it was based solely on the 'Greek miracle', the rest of the Old World having stood wondering aside, quaint and uncouth. Dr. H. J. J. Winter is one of the most eminent experts on Arabic science, and the authority of his sources is for the most part not only unexceptionable but in this book also accurately transmitted. Although the book is pioneer and preliminary in nature, it ought to be placed on the shelves of every library which has even a small section devoted to the history of science, not only in English-speaking countries but everywhere.

The first part speaks of the ancient river-valley civilizations of Mesopotamia and Egypt, dealing mainly with mathematics (and using the work of Neugebauer) and medicine. It then touches upon the

ancient Indian contributions (for example, Kautilya, Susruta) before speaking of those from China, such as the astronomy of the classical period, Mohist optics and mechanics, Han harnessing technique, the alchemy of Li Shao-Chün, and so on. The Chinese theme is continued into the Middle Ages, discussing Chin dynasty writers on plants and animals, T'ang physicians, Sung algebraists and philosophers, and inventions such as those of gunpowder and printing. The longer treatment of Indian mathematics adopts the right attitude that, while some of the claims for high antiquity which Indian scholars have put forward cannot be accepted, great dependence on Greek mathematics cannot be substantiated either. The largest part of the book comes next, namely, that devoted to the contributions of the Arabs, or rather those who wrote in the Arabic language. They concern mostly mathematics, physics and medicine, for, on the technological side, the Arabs were not great innovators. This section is, of course, that in which the author is most at home, and it is excellently done.

Probably Dr. Winter's expert knowledge of Arabic science accounts for certain general nuances which at times appear. If the introduction seems unexpectedly devout, this is perhaps due not only to the series in which the book appears, but also to the Arab convention of adding, whether in a chemical or astronomical discussion, that in any case God knoweth best. But this has led the author into saying in his introduction (and his conclusion) that on the whole Asian interest in scientific ideas and methods was philosophical and æsthetic, not concerned with practical applications. Everything we know of Chinese science contradicts this, as the author himself has to recognize on p. 36. True indeed is his final conclusion that the study of Asian science makes one realize the unity of science as nothing else can, and the dependence of Europeans on Asian initiators much more often than is commonly supposed. But his picture of four consecutive stages, the Ancient Empires, Greece, Asia (especially Islam) and lastly western Europe, is not quite satisfying; surely it would be truer to say that the science of the ancient empires of the Fertile Crescent passed in both directions, to China and India on one hand and to Greece on the other, each culture-area developing them in their own way. Islam united the traditions to some extent, and certainly transmitted much from east to west.

JOSEPH NEEDHAM

HISTOLOGY IN TRANSITION

Histology

By Prof. Arthur Worth Ham. Second edition. Pp. xix+866+7 plates. (Philadelphia, London and Montreal: J. B. Lippincott Company, 1953.) 80*s*.

HEINRICH FREY in his text-book of histology published in 1874 says, "without a knowledge of composition, true scientific study of histology is impossible and the latter is in danger of degenerating into a mere toying with details". For the greater part of this century and even to-day in many medical schools in Britain, histology, certainly as it is taught to medical students, has been little more than 'toying with details'. But during the nineteenth century it was a dynamic subject: its investigators imbued with the spirit of investigation, not merely of "structural elements" but also of "the substances occurring in the latter, their introduction, origin, and the significance they possess in the life of the form and tissue elements . . . their metamorphoses, decomposition and elimination". This was a period which bred the great figures in histology: Ranvier, Müller, Purkinje, Henle, Schwann, Koelliker, Remak, and many others. It was a period when even the Royal College of Surgeons boasted a professor of histology in the form of John Quekett; when Frey and his colleagues spoke rather scornfully and apologetically of "topographical histology" and bemoaned the limitations to their discovery imposed by the modest knowledge of organic chemistry which then existed. Even so, 'histochemistry' was attempted and was in fact known by this name, and a text-book of histochemistry was published by Schlossberger.

This tradition was maintained by the publication in Britain in 1902 of Gustav Mann's remarkable "Physiological Histology" which, though primarily a book on technique, stressed the histochemical and physiological side of the subject. He complained even then that "the ordinarily accepted view that histology concerns itself merely with micro-anatomy seems to me a narrow one". Unfortunately, this view has persisted for a very long time and is only now beginning to pass through a period of transition. Part of the reason for this is that histology in Britain has never been free to develop for itself but has always been tied either to physiology or to anatomy; and yet it is a discipline very different from both these subjects and, with the rapid development of the more difficult discipline of histochemistry, it becomes more and more a subject that needs its own specialists if it is to develop as it should.

Lack of senior posts and therefore of careers in histology has been one of the major factors which have stifled the development of the subject in Britain. However, across the Atlantic, where even professors of histology exist, histology and particularly histochemistry are developing with great rapidity. A professor of anatomy in charge of histology at the University of Toronto, Arthur Ham, published in 1950 an outstanding text-book of histology which was fully in the tradition of the nineteenth-century histologists. The second edition of this has just appeared and is a large work of 866 pages and 518 figures, including seven plates in colour. The size, although it makes for completeness, is of course secondary to the content, and in this respect the second edition not only lives up to the high reputation of its preceding edition but surpasses it. Most of the sections have been enlarged and others re-written, and new illustrations have been added. The reviewer was particularly attracted by the introductory chapter, which showed the relationship of histology to other medical subjects, and by the illustrations explaining the appearance of tubes which had been cut in various ways in histological sections. The other sections of the book deal with the microscopical anatomy and the chemical nature (where this is known) of organs and tissues and their components and with their function. At the end of each chapter is a most useful list of references, and there are nearly twenty pages of subject index at the end of the book. The price of 80*s*. makes it a very expensive book for students; but there is little doubt that it is the best value of any histological book at present on the market, and it is an essential component of every histological laboratory.

G. H. BOURNE

Progrès récents de la chromatographie

Première partie: Chimie organique et biologique. Par Dr. Edgar Lederer. Pp. 146+3 plates. Deuxième partie: Chimie minérale. Par Michael Lederer. Pp. 131. (Actualités scientifiques et industrielles, 1079 and 1181.) (Paris: Hermann et Cie., 1949 and 1952.) n.p.

THESE two volumes on recent progress in chromatography have been prepared by authors who have themselves made significant contributions in chromatography and, taken together, form a useful guide covering the whole field of separation studies by this method. The general arrangement of subject-matter follows a similar plan in both cases in providing chapters dealing with adsorbents, solvents, techniques and a wide variety of applications. Chromatography on cellulose, which represents the most important advance in recent years, receives due notice; but there are also chapters dealing with electrophoresis, ion exchange and earlier work on alumina and other solid adsorbents. The information provided in these books, although necessarily brief, is reliable and clearly presented. The main function of books of this kind is to stimulate the interest of the reader in what may be an unfamiliar field, to describe what has been done and to provide references to original literature where more detailed information can be found. The authors have performed this task very well; but in such a rapidly advancing subject it is important that the work should be as up to date as possible to be of maximum usefulness. Part 1, published in 1949, loses something of its value at the present time from absence of descriptions of work done during the past few years, but forms a useful introduction to the subject. Part 2 gives a good account of inorganic chromatography up to the end of 1951. Work in the latter field has progressed rather more slowly than in organic and biological chemistry but has already proved of exceptional value in separations which are difficult to accomplish by other procedures. This little book by Michael Lederer should go far towards making inorganic chromatography better known and appreciated, particularly in France. F. H. Burstall

Introduction to the Foundations of Mathematics

By Prof. Raymond L. Wilder. Pp. xiv+305. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.) 46*s*. net.

IF the question be asked whether or not this book is just 'yet another' addition to the collection of texts on fundamentals, the answer is an emphatic 'No'; and for the following reason. Prof. R. L. Wilder has, in effect, written two volumes in one. The first, on concepts and methods, is the result of much teaching experience; it is helpful and readable, but not particularly original. The second, however, dealing with the "development of various viewpoints" is, in my opinion, outstanding and fully justifies placing this work in a class by itself. After discussing the various 'schools' (for example, intuitionism), come some twenty pages devoted to the cultural setting of mathematics, considered both genetically and historically. Nothing quite like it has appeared since Pickford did much the same, in a monograph, for the fine arts a decade or so ago.

Broadly, the thesis is that, like other cultures, mathematics shows a growth conditioned by evolution and by diffusion. The common influences like migration, cross-infection and the like are shown to apply. Individual men of genius arose because the cultural environment 'required' them, rather than the other way round. Seen through contemporary eyes, the modern *Methodik* may soon invade psychology and the social sciences, a hypothetical movement at present, but reminiscent of the prophetic remark by the late Prof. A. N. Whitehead on a similar theme. Whatever eventually happens, Prof. Wilder's outlook is invigorating, and worthy of close attention by teachers and by students alike.

F. I. G. Rawlins

A Century of London Weather

By W. A. L. Marshall. (Air Ministry: Meteorological Office, M.O. 508.) Pp. ii+103+29 plates. (London: H.M. Stationery Office, 1952.) 15*s*. net.

THE weather of London is of interest to a good many people, especially this year, and this official compilation was very timely. It is based on the records at the Royal Observatory, Greenwich, since 1841, the Kew Observatory, Richmond, since 1871, and some shorter records for other parts of London, including Kingsway. It opens with summaries for 1841–1949, giving the warmest and coldest years, months, days and nights, extremes of rainfall, snow, thunder, sunshine, drought, frosts and fog. The section on seasons includes comparisons of the temperature and rainfall of each season with those preceding and following. There is a slight tendency for abnormal conditions to persist into the following months, but with so many exceptions that the relation is useless for forecasting. A long chapter describes diurnal and annual variation of visibility in various parts of Greater London. Frequencies of warm and cold spells at different times of the year are discussed, but little support is found for Buchan's famous spells. Nearly half the book is taken up with monthly tables of temperature, rainfall and, after 1880, sunshine for each year, 1841–70 at Greenwich and 1871–1949 at Kew, and with graphical presentations in coloured plates of most of the material in the tables. It would be difficult to think of any query about London weather which cannot be answered from this book, but an explicit reference might have been made to the question of changes of climate—for example, the index includes no reference under "old-fashioned winters".

Embryology

By Lester George Barth. Revised and enlarged edition. Pp. xi+516. (New York: The Dryden Press, Inc., 1953.) 6 dollars.

IN this revised and considerably enlarged edition, the essential framework of the original work has been retained. The author's aim is to discuss the general principles of embryology and to illustrate relevant anatomical data over a wide taxonomic range. In particular, the new materials lay emphasis on the development of the nervous system and the derivatives of mesoderm; but new and valuable additions have been made at many points. An unusual feature of the book is that, to afford students a more thorough grasp of comparative embryonic development, illustrations of the development in frog, chicken and mammalian embryos have been so arranged, on a detachable system, that any organ can be studied either chronologically through its development in one animal, or comparatively in several animals simultaneously. Both the text and illustrations are of an admirable clarity.

THE ROYAL SOCIETY

ANNIVERSARY ADDRESS BY DR. E. D. ADRIAN, O.M., P.R.S.*

AWARD OF MEDALS, 1953

Copley Medal: Prof. A. J. Kluyver, For.Mem.R.S.

PROF. A. J. KLUYVER has held the chair of microbiology at Delft since 1921 and has become a world authority on general microbiology and the biological approach to its problems.

In 1923 he made a survey of natural processes known to occur through the agency of micro-organisms, and this survey has been the cornerstone of his work for almost twenty years. Impressed by the bewildering variety of substances (both inorganic and organic) used by these organisms for their growth processes and by the equally great variety of substances formed as the end-products of metabolism, he sought some underlying uniformity in the basic types of chemical change which occurred. Devoting himself mainly to bacterial fermentations, he found this uniformity in the extension of the concepts of Wieland and Thunberg that biological oxidations occur by successive transfers of pairs of hydrogen atoms to a suitable acceptor. His views were confirmed by a series of studies covering all the principal bacterial fermentations of carbohydrate. These researches also led him to believe that, in spite of the many and varied products formed, the degradation of carbohydrate took place stepwise by a series of simple reactions leading to a limited number of common intermediates. The initial stages were alike and the variation came later through the differing enzymic constitution of the cells and the differing effects of changes in the environment on such enzyme reactions. These views have been amply confirmed and, apart from its broader implications, the work on fermentation remains a source of some of the most accurate data in the field.

Kluyver's views on the uniformity of basic cell processes in all types of cells are now widely accepted and form the basis of comparative biochemistry (a term first used by Kluyver himself). As early as 1931 he pointed out the advantages of micro-organisms for this kind of work, not only because of their biochemical versatility, but also because of the relative ease of working with them under fully controlled conditions.

Kluyver's research and thought have always been directly towards the ultimate problem of the life of the organism in its natural environment, and his broad and critical knowledge of all branches of microbiology has been an inspiration to his pupils, many of whom, in various countries, are in the front rank of microbiologists. His scientific eminence was recognized in his own country by his election a few years ago to the presidency of the Royal Netherland Academy of Sciences.

Royal Medal (A): Prof. N. F. Mott, F.R.S.

Early in his career, Prof. N. F. Mott's work in the field of atomic collisions attracted widespread attention. He was the first to show that Rutherford's scattering law holds in quantum mechanics, and to give an accurate theory of the effect of symmetry in scattering problems. When, at the age of twenty-seven, he became professor of theoretical physics at Bristol, he abandoned this subject for that of the theory of metals and alloys, and within a few years he was recognized as one of the leading international authorities in this field. His papers on electronic bands in metals and on the electrical conductivity of alloys and its temperature coefficient have markedly influenced the lines of experimental approach in a field in which the literature was already vast. He has also contributed to the important problem of metals under strain.

Later, he turned to semi-conductors and insulators, throwing light on the physical processes involved in the formation of oxide films and in the electrical conductivity which can be induced by various means in polar crystals. His theory (with Gurney) of the formation of the latent image in a photographic emulsion has found general acceptance, and has stimulated fresh experimental work in research departments of the industry.

During the Second World War, as superintendent of theoretical research in the Armament Research Department at Fort Halstead, he made an outstanding contribution to the theory of the fragmentation of shell and bomb cases under the effect of the explosive charge, and on his return to the H. H. Wills Laboratory at Bristol he has directed work of great importance on the mechanical properties of materials. Mott's personal contributions have been mainly to the theory of plastic deformation in metals, developing the understanding of bulk behaviour in terms of microscopic derangements of the crystalline structure. His ability to establish close and effective association between theorists and experimenters is shown by the outstanding advances which have been made at Bristol under his direction, in the various branches of the physics of materials.

Royal Medal (B): Sir Paul Fildes, O.B.E., F.R.S.

Although the outstanding contributions of Sir Paul Fildes to the science of bacteriology have come from his researches in bacterial chemistry, his earlier work on the cultural requirements of the influenza bacillus and some of its relatives added materially to our knowledge of the genus *Haemophilus*, and his brilliant studies of the behaviour of the tetanus bacillus and its spores *in vivo* and *in vitro* were a major contribution to the natural history of this micro-organism and the disease it produces.

This work brought to Fildes the conviction that full knowledge of nutritional requirements was essential for a proper understanding of the life-processes of bacteria. He gathered a small team of bacteriologists, chemists and biochemists which was formally established as a Medical Research Council Unit in 1934, and together with the late Dr. Marjory Stephenson he was largely responsible for the development of chemical microbiology in Great Britain. The period 1930–40 saw the discovery by the Unit of a number of hitherto unrecognized

* Delivered at the Royal Society on November 30.

bacterial growth factors (for example, nicotinamide, uracil, glutamine) and the establishment of the detailed amino-acid requirements of several organisms. Concurrently, the specialized technique required was being worked out and has contributed largely to that in common use throughout the world to-day.

Fildes was always interested in the wider aspects of bacterial nutrition and early showed that organisms could be 'trained' to synthesize essential nutrients such as amino-acids. This field has been intensively developed, particularly since the advent of modern biochemical genetics, in other laboratories.

Fildes believed that the inhibitory action of some anti-bacterial agents might be due to interference with the metabolism of essential nutrients. The Unit's outstanding achievement in this field was the demonstration that sulphonamides act by inhibiting the utilization of *p*-aminobenzoic acid. This concept has stimulated an enormous volume of work on the possibility of designing anti-bacterial substances which might prove useful therapeutic agents or valuable tools in biochemical research, and it has also proved of great value in studying biosynthetic pathways.

Fildes's work during the War was outstanding, and since his retirement he has continued his work on chemical aspects of microbiology, and with the aid of young collaborators is adding significantly to knowledge of bacteriophages.

Davy Medal: Sir John Lennard-Jones, K.B.E., F.R.S.

Sir John Lennard-Jones's principal contributions have been to the modern theory of valency and molecular structure. In 1929 he published papers which laid down the foundations of the so-called molecular orbital method for the discussion of diatomic molecules. Among its first successes was the clarification of the triplet nature of the state of the oxygen molecule O_2. The foundation thus laid was built upon by very many authors, who applied the method to the analysis of the complex relations among the numerous group of organic compounds known as conjugated molecules. Almost an entire branch of the modern literature now consists of what are virtually applications of the original Lennard-Jones technique, and it has been shown that many subtle and surprising properties of such compounds follow from their structure in an intelligible way.

With a series of colleagues he has extended the theoretical treatment of the liquid and solid states. He has made calculations of the interatomic forces in the rare gases and other simple substances, and used the results to formulate a law of force applicable to ions in crystals. With the aid of this the lattice properties have been calculated and the results have illuminated the general picture of the solid state.

His papers on the liquid state have dealt with fundamental properties such as boiling points and critical temperatures, and further increased our understanding of the relations between molecular forces and the properties of substances.

As a complement to this abstract theoretical work, Lennard-Jones worked throughout the Second World War and after on various problems of vital practical importance connected especially with ballistics. In 1942 he was appointed chief superintendent of the Armament Research Department, where he bore extremely heavy and complex responsibilities. Later, he was chief scientific officer to the Ministry of Supply, and has now succeeded Lord Lindsay as principal of the new University College of North Staffordshire.

Hughes Medal: Sir Edward Bullard, F.R.S.

Sir Edward Bullard's earlier research work, on atomic physics, was done in the Cavendish Laboratory under Lord Rutherford, and it was Lord Rutherford who specially recommended him to Sir Gerald Lenox-Conyngham as suitable to undertake research in the Department of Geodesy and Geophysics, Cambridge. In that Department, where for some years he was Smithson Student of the Royal Society, he carried out a notable series of investigations of far-reaching importance. His clear insight and experimental skill enabled him to tackle difficult problems with a directness and freshness of approach that made them appear deceptively simple.

Bullard's determination in 1932 of the value of gravity at a number of stations in terms of the value at Cambridge was achieved by comparing the time of oscillation of a pendulum swinging at Cambridge with the time of oscillation of a similar pendulum swinging simultaneously at a field-station. These results were of considerable geophysical interest, and were followed by similar interconnexions by Bullard and others between pendulum stations in Great Britain; in 1936, the available modern gravity determinations, mainly carried out under the supervision of Sir Gerald Lenox-Conyngham, were collected and critically discussed by Bullard and Jolly, so that gravity measures in Great Britain were combined in a coherent scheme, forming a basis for later work on gravity, much of which was carried out or inspired by Bullard. The Cambridge apparatus has been lent to a number of observers in different parts of the world; the reduction and discussion of the results of some of the earlier of these expeditions (in the Sudan, Tanganyika and Cyprus) were carried out by Bullard.

In 1938 he initiated a series of expeditions in submarines for the determination of gravity at sea, using the Meinesz apparatus to investigate the continental shelf to the west of the British Isles. Meanwhile, with geophones of his own design, he delineated the palæozoic floor of East Anglia.

Many discussions had already been published of the thermal gradients in bore-holes, and it had been thought that the rate of outflow of heat differed markedly in different parts of the world; but the heat conductivity had never been measured on the actual bore-hole specimen. This unsatisfactory state of the subject was largely cleared up by Bullard, whose investigations in South Africa showed from measurements of heat conductivity of the rocks at different horizons that the rate of upward flow of heat across any section of a given bore-hole was the same. Further, a critical discussion of the data showed that the outflow is sensibly the same in all the continental regions of the globe. There remained the question of heat-flow through the ocean floor. This was first determined by Bullard in 1949; he devised a hollow steel 'spear' which could be driven vertically into the ocean sediments and left for about thirty minutes in order to reach thermal equilibrium. Experiments carried out with this apparatus in the Pacific Ocean have indicated an outflow of heat which is much the same as that through the continents, though determinations made in the Atlantic by Bullard in 1952 gave a rather lower heat-flow.

In recent years Bullard has written a number of important papers on the causes of the earth's mag-

netic field and, despite the heavy demands of administrative work as director of the National Physical Laboratory during the past four years, he has contrived to continue his own geophysical researches and to inspire and facilitate the researches of others.

THE GROWTH OF NATURAL KNOWLEDGE

The object of the Royal Society is the improvement of natural knowledge. It began when the search for this kind of knowledge was little more than the amusement of the curious, and we have now reached the stage when it increases so rapidly that there is not enough paper to be found for printing all that comes to light every year. It is true enough that the early virtuosi had no abundance of paper. Isaac Newton's letters, soon to be published in a collected edition by the Society, are written as closely as possible, and he and his contemporaries made their notes on every scrap of paper they could find. But what troubles us now is not the scarcity of writing material but the abundance of finished manuscript waiting to be published. We know, too, how little of it we are likely to read ; although we are bound to regret the slowing down of productive work in academic science during the war years, I think those years will be recalled by many of us as the time when we had no piles of unread journals and reprints to be ashamed of. Nowadays the piles would be even larger if publication were easier, for scientific research has become one of the major interests of mankind and we cannot escape the consequences.

One consequence, which weighs heavily on me at the moment, is that it has become increasingly difficult to pick out some special discovery or specially active line of work to bring before the annual meeting of the Royal Society. There has been great activity in many lines ; but for the time being we seem to have passed the stage of really startling discoveries. In the most promising fields there are already so many scientists at work that the general line of advance can be foreseen for a few years at least. We cannot, of course, foresee the sudden illumination which comes from time to time to put some branch of science on a new footing ; but it would be safe to foretell that very soon the chemists will have synthesized more natural products, that we shall know much more about the structure of the proteins, about the nature of viruses and the action of enzymes, about the products of atomic disintegration and the physical properties of matter at very high and very low temperatures. Valuable discoveries will certainly come in all these fields ; but we are well prepared for them : they will not startle us unless they show some fault in the accepted theories, and most of them are already based on a wide range of evidence.

The rapid expansion of scientific research has another consequence which must be of some concern to a Society which deals as we do with the whole domain of natural knowledge. In the past it was a domain with isolated fields, each yielding a different crop and mostly separated by tracts of unexplored country. It was easy to classify scientists as chemists, physicists, zoologists and botanists, and so on. They had different data to bring together and a different way of dealing with them, with a different vocabulary and different apparatus ; as soon as we were through the door we knew whether we had come to the right laboratory. But it is becoming far more difficult nowadays to decide where the boundaries should be drawn ; the major fields are experimenting with new crops, and the barren areas which used to separate them have begun to yield fruit and to attract workers from distant regions. Mathematics and physics and chemistry lead without a break into the biological fields, and it needs more than a casual glance to tell whether we are in a laboratory which studies the atom or the human brain.

We should all rejoice that the old barriers are yielding, for we aim at a single inclusive system of the world, one that will cover all the immense variety of natural events. Yet they have an immense variety and it is still necessary to classify them. For a society like ours the classification ought not to go into much detail. There must be committees with suitable labels ; but if we are to judge the importance of different lines of inquiry there must be as much overlapping as possible, so that a new line of work can be considered by experts who are not all biased in the same direction. But in their own laboratories the different branches of science must be free to take their own course and, though the major groups are content with their traditional labels, the pioneers who work in new territories need new ones. We are all too familiar with the passions aroused at the thought of independence from 'overlords' who were once powerful, and so we cannot be surprised when a group of workers in a new field demand a label which does not saddle them with wider scientific loyalties. No one ought to, or can, stop them from having their own journals and meetings, and if they want it they must be allowed the satisfaction of using a sign language that no one else understands. The chief difficulty arises in connexion with the international organizations which maintain contact between the scientists of different countries. They perform a valuable, in fact an essential, service, and this is recognized by the financial support which they receive from national governments by way of direct subscription or indirectly by way of such bodies as Unesco. But the available funds are limited, and every year new international unions arise to claim acceptance by the International Council of Scientific Unions and of the countries which support it. Advisory bodies faced by this multiplication of clients are already finding it hard to weigh the claims of new and old, of the small bands of enthusiasts eager to meet colleagues scattered over remote countries, and of the powerful established societies with congresses attended by thousands and an elaborate organization to keep in being.

The problems of the borderline subjects and of the specialist groups are bound to grow as the content of natural science increases ; but they are signs of progress and will no doubt be settled as they arise, by reasonable compromise. I have mentioned them chiefly to emphasize the more general difficulty of keeping our enormous territory in focus. It has long ago passed the competence of one mind, and it will need a more and more highly organized co-operative effort if we are to make the best use of our time.

The ability to make such an effort is, of course, our birthright. The human brain surpasses that of other animals in its capacity for what Henry Head called 'symbolic thinking and expression' ; it is because we can communicate our thoughts that two heads are better than one, and because we can express the results in permanent form by pictures or writing that each generation has a greater store of knowledge than its predecessors. Individually we can be specialists, because, in Isaac Newton's phrase, we stand on the shoulders of giants.

We are rapidly improving the mechanical devices which ought to help this upward progress. We can pay a week-end visit to a colleague in California if our ideas are still too vague to be reduced to writing; and besides the microfilms and new printing and copying devices there are the electrical recorders which are now so often used for ensuring that no single word spoken at a scientific congress shall be lost to posterity. These potential benefits are not at the service of scientists alone, but we must assume responsibility for their introduction. Aeroplanes and tape recorders can certainly assist scientific research, but only if we keep them as servants and not as masters.

It would be easier to keep our instruments and records in their proper place if we knew more about our own capacities, about our ability to profit by discussion or to extract what we need from a store of information. We have no scale for measuring such abilities, but we have a new line of approach which will certainly help their investigation. When the British Government in 1823 gave Charles Babbage a substantial grant for his calculating machine the technical difficulties proved insuperable; but Babbage could construct a machine on paper which should have been able to solve most of the problems which are dealt with by the new electronic instruments. It could even work miracles, for Babbage pointed out that his machine could be arranged to produce at intervals of a thousand years or more a single abnormal event which might well appear to be an interference with the course of Nature. With our modern instruments, miracles of calculation are possible because the operations can be carried out at an unimaginable speed; a vast number of figures must be dealt with and some of them must be stored for a limited time, but if the machine is to be of reasonable size they must be stored no longer than they are needed and in a space which can be constantly used for new sets of figures as the calculation proceeds. Thus the record must be of a kind which will vanish instantaneously and completely when the need for it is over.

One way of achieving this is to arrange for each item to set up a cycle of operations, electrical or mechanical, which will repeat itself indefinitely at a high rate but will cease immediately when fresh items appear. In the system due to Prof. F. C. Williams, 1,000 digits can be kept alive as long as they are wanted on the screen of a cathode ray tube, and the value of each can be read with a delay of not more than a few microseconds. There would be no great difficulty in arranging so that a repetition of the cycle for an hour or more should induce some structural change in the machine, a storage which would not need a constant supply of energy to maintain it; but there would be little to be gained, for it is better that the machine should start each morning as a clean slate. Its code of instructions can be given a permanent form, but the cycles of activity which keep each digit alive are ended abruptly when the current is turned off.

The human brain can neither remember nor forget with such precision—if it could we should be in a far better position to assess its powers. There are too many variables to be considered. The items of information coming from the sense organs are not all treated in the same way: a few are given priority for the storage process and many are unnoticed; and signals which reach the brain may be stored for a time as self-perpetuating cycles of activity, but before long the traces leave some more enduring change which does not need constant renewal. Thus the telephone number we have to dial can be kept alive in our mind by constant repetition like the numbers in a calculating machine; but we cannot be sure of forgetting the number completely when we have made the call.

The formation of some kind of stable trace can be inferred from the fact that memories survive periods when the brain is almost completely at rest. We must start each morning with our brain structure modified by what happened to it the day before: the deepest sleep or anæsthesia or coma, in fact the most complete cessation of activity short of death, will not make the brain a clean slate with no traces of our mother tongue or of the manual skills we learnt in infancy. Thus we may be able to say precisely how many items of information can be carried in an electronic machine for how long, but we cannot hope to answer the same questions for the human brain until we know far more about the nature of its storage processes. What we can learn from the machines is how our brains must differ from them.

There are already some indications of the kind of alteration which may be produced in a nerve cell by repeated activity. It is well known that repeated stimulation of the nerve cells of the brain produces an increased responsiveness which can last a minute or more; and Eccles and his colleagues have recently shown that even in the spinal cord, the function of which is purely executive, a long period of inactivity leads to a loss of responsiveness which is restored by a short period of enforced activity, and when restored tends to persist for a matter of hours. What physical or chemical changes are responsible for these alterations is still unknown, but we have a new method, introduced by Eccles, for studying the biophysics of the nerve cell by the use of a microelectrode thrust into its interior. The method was first used in the study of muscle fibres: its extension to the nerve cell has already given important results and cannot fail to give more.

It is naturally more difficult to study the biochemistry of the individual nerve cell than to study its electrical properties, but the storage process may well involve a chemical as well as a physical reorganization. If the cell chemistry of a grown man can bear the mark of an infection with measles in childhood, it is not unreasonable to suppose that the nerve cell constituents are plastic enough to be modified by past activity. Evidence accumulates in favour of the view that the transmission of signals from one cell to another depends on the release from the cell terminals of stimulating molecules, and their rapid destruction by enzymes. The stimulating molecules so far discovered, acetyl choline and perhaps *nor*-adrenalin, are of relatively simple structure; but we know too little about the enzymes to be sure that the destruction of the stimulus will always proceed at a uniform rate uninfluenced by the past history of the cells.

I have reason to be impressed by the versatility of the nerve cell in relation to chemical stimuli, for I have been trying for some years to find out how the olfactory organ enables us to distinguish an immense variety of molecules brought to it in the air. The receptor cells number several millions but they differ very little in external appearance; and for a time I thought that the discrimination of one smell from another depended more on the particular regions

stimulated than on the particular receptor cells. But it is becoming more and more certain that there are marked differences in the specific sensitivity of the receptors. One group will react most readily to aromatic molecules, another to particular terpenes and so on. These differences are no doubt permanent, but they show that cells which look alike may have some physico-chemical organization which makes them react quite differently to a particular stimulus. It is perhaps to be hoped that the cells of our brain have a more uniform constitution, and that memory traces depend on biophysical rather than biochemical alterations. It will certainly be easier to detect the former; yet until we know more about the nature of these traces, we cannot begin to understand what is by far the most important property of the brain.

OIL POLLUTION OF THE SEA

AT the International Conference on Oil Pollution of the Sea, which was held in the Lecture Hall of the Institution of Electrical Engineers, Savoy Place, London, on October 27, representative private citizens of many nations met together for the first time in a concerted effort to press for action on the evils caused by oil pollution of the sea. The Conference was organized by the Co-ordinating Advisory Committee on Oil Pollution of the Sea, of which Mr. James Callaghan is chairman. This is an independent Committee composed of representatives of the interests in Great Britain which are most affected by oil pollution, namely: Association of Municipal Corporations, Association of Sea Fisheries Committees of England and Wales, Council for the Preservation of Rural England, Council for the Preservation of Rural Wales, County Councils Association, General Council of British Shipping, International Committee for Bird Preservation (British Section), River Boards Association, Royal Society for the Prevention of Cruelty to Animals, Royal Society for the Protection of Birds, Rural District Councils Association, Universities Federation for Animal Welfare and the Urban District Councils Association, with individual members who are experts on different aspects of the question.

In the formation of the Committee in March 1952, the efforts of many organizations which had for years been working individually to secure a solution of the problem of oil pollution were co-ordinated and canalized. On July 21, 1952, the Minister of Transport announced in the House of Commons that he had decided to appoint a committee to consider what measures could be taken to prevent oil pollution of the sea, and on October 2 the constitution of this committee, which was entitled the Committee on the Prevention of Pollution of the Sea by Oil, under the chairmanship of Mr. P. Faulkner, was announced. The report of this Committee was published in July this year, and the purpose of the Conference just organized by the independent Co-ordinating Advisory Committee on Oil Pollution of the Sea, and presided over by Mr. J. Callaghan, was to bring the findings of this report before public opinion in all countries.

In opening the Conference, the Minister of Transport, Mr. Alan Lennox-Boyd, stated that it is realized in the United Kingdom that legislation is required to implement the recommendations of the Faulkner Report; but it is also recognized that action by one country alone, though important, is not enough. He then announced that the Government is taking steps to call a conference of maritime governments to consider how the trouble could be ended. He had in mind that it might be similarly organized to the Conference on Safety at Sea, held in 1948, which was followed by swift action, and concluded by stating that he hoped its recommendations would be as speedily adopted.

Lord Hurcomb, president of the Society for the Promotion of Nature Reserves and, until recently, chairman of the British Transport Commission, in introducing the report of the Minister of Transport's committee on oil pollution, stated that there is no dispute as to the gravity and extent of the mischief, nor is there any room for dispute as to the cause of the trouble or the remedies for it. The remedies are clear, and all that is needed is the will to apply them. He pointed out that the Minister's committee, which included two shipowners and two representatives of the oil companies, has stated in its report that "in recent years the nuisance has become intolerable". He expressed appreciation for the speed and admirable precision with which the committee has reported, and said that its inquiries have been thorough and it has pointed firmly and fearlessly to the remedies, after satisfying itself that those remedies are entirely practicable. Lord Hurcomb continued that the problem reduces to the fact that the only way to avoid polluting the sea, fouling the beaches and destroying birds, is not to put persistent oil sludges and waste into the ocean, but to separate them and to discharge them ashore. To prohibit discharge within a prescribed distance of particular coasts is a mere palliative, though necessary as an interim measure. It has been shown that even a limit of 150 miles would not give the United Kingdom a remedy, and the only long-term policy is to prevent the discharge of persistent oils into the sea altogether. For this to be practicable, suitable and adequate facilities for the reception of oily waste should be provided at all loading terminals and repair ports throughout the world. Lord Hurcomb concluded by stating that weary years of international argument in the hope of securing complete agreement should not be contemplated, and asked that a date for achieving the ultimate policy should not be timidly fixed too far ahead.

Mr. Donald F. Anderson, chairman of the General Council of British Shipping, spoke on the problem as the British shipowner sees it and stated that their general attitude is already known by the solid fact that British shipowners have accepted the report and recommendations of the Faulkner Committee, and that they decided as soon as it came out to put into practice some of the measures. He stressed that, though they are doing all they can to help in solving the problem, it would take more than action by British shipowners before there could be any material improvement, and he alluded to the vast amount of shipping under other flags which goes up and down the English Channel without touching the United Kingdom. He concluded by saying that goodwill among shipowners of the leading maritime countries is not enough. If the aim of preventing oil getting into the sea anywhere is to be reached, this can only be achieved if vessels of all flags are bound by a convention among all the nations with ships that sail the seas.

Sir Douglas Ritchie, chairman of the Executive Committee of the Dock and Harbour Authorities Association, pointed out how difficult it has proved to detect offenders under the Oil in Navigable Waters Act, particularly as some part of the pollution of inland tidal waters is caused by oil discharged, or escaping, many miles away at sea and being carried to the coasts. He described the facilities which have been provided for the collection of oily water in ports and stated that these have, unfortunately, not been used to any real extent. His Association welcomes the recommendations of the Faulkner Committee and has made it clear that it would be prepared to co-operate in providing, or securing the provision of, adequate reception facilities at the ports.

In May 1952 an independent Scandinavian Committee on Oil Pollution of the Sea, consisting of representatives from Finland, Sweden, Norway and Denmark, was set up at an international meeting of sportsmen in Finland. This committee was represented at the London Conference by its chairman, Captain Berno von Bornstedt, and Major Bertil Funck (Sweden), with Mr. Mogens Blach, director of the Port of Copenhagen, and Mr. Moltke-Leth, of the Danish Hunting Society. Mr. Blach described the havoc caused by oil pollution on Danish shores and mentioned the voluntary efforts in abstaining from the discharge of waste oil made by Danish shipowners. He said that it is understood in Denmark that the evil cannot be eliminated until international agreement is reached, and it is felt that it is the duty of any interested country to do everything possible to have the question dealt with on an international basis. Major Bertil Funck outlined the measures regarding oil pollution which have been taken in Sweden and referred to the recommendations which were made at the Baltic and International Maritime Conference in Stockholm in 1951. He stated that the Scandinavian Committee supports the recommendations of the British report and proposes that the Scandinavian Governments should, as soon as possible, seek the agreement of the Baltic and North Sea countries for fixing a date after which discharge of persistent oils into the sea should be prohibited.

A report from Mr. Banks Belt, chairman of the Atlantic Waterfowl Council, New York, directed special attention to the need for educating crews in care in preventing oil pollution.

Dr. H. Lillie, formerly a surgeon with an antarctic whaling fleet, urged that whatever legislation is introduced internationally should cover operations of the whaling industry in the Antarctic and other seas. He described half-grown seals covered in a thick tarry mess, their eyes bloodshot with irritation, and penguins hopelessly clogged waiting a slow death.

Sir John Simonsen, speaking on the need for further research, stated that the separation of oil–water emulsions is not a problem easy of solution. What is required is a plant cheap to buy, occupying little space and requiring for its operation the minimum of technical control. Plants and methods are in use which have proved successful, but further work is necessary. If governments insist, and it is hoped they will, that oil pollution must cease, research on this problem might well be undertaken in a government research institute. It would require the joint work of a physical chemist and chemical engineer. Two speakers described plants for dealing with waste oil, and Mr. W. Killner stated that the process he has developed while in Admiralty service does not require specialized technique or elaborate equipment and is suitable for use in merchant ships. Full information is in the hands of the National Research Development Corporation.

At the close of the Conference a declaration of aims was unanimously adopted, supporting the view that ships of all nations should be required to refrain from discharging persistent oils into the sea, noting with satisfaction the co-operation of the shipping industry and oil companies, recognizing the need for international agreement and undertaking to stimulate public opinion regarding this, welcoming the announcement of the Minister of Transport regarding the calling of an international conference and urging that statutory provision be made to ensure adequate facilities for the reception of oily residues at ports, oil-loading terminals and repair yards.

In addition to the representatives of Belgium, Denmark, Finland, Sweden, Norway, the Netherlands and South Africa who attended the Conference, twenty-six nations were represented by observers from their embassies, legations, diplomatic missions and high commissioners in London.

STANDARDIZATION OF RADIOACTIVE ISOTOPES IN GREAT BRITAIN

By W. E. PERRY

National Physical Laboratory, Teddington

SINCE the end of 1950, four organizations in Great Britain—Atomic Energy Research Establishment, National Physical Laboratory, Radiotherapeutic Research Unit of the Medical Research Council and Royal Cancer Hospital—have been collaborating in the measurement of radioactive isotopes on an absolute basis, that is, in determining the number of disintegrations per second in a given sample. It seems an appropriate moment to review very briefly the work which has been done so far; a fuller report on the measurements (up to the spring of 1953) is obtainable on application to the Director, National Physical Laboratory, Teddington.

The impetus for undertaking this work came partly from the recommendations of the Joint Commission on Radioactivity and of the International Commission on Radiological Units. The aim has been to assess the reliability of different methods, to improve and develop them, and to introduce ultimately a system of standardization appropriate to the more important isotopes, particularly those of relatively short half-life. Some users of radioactive isotopes are, of course, not much concerned with absolute values; but others, for example, clinical users, must have an absolute basis for their work with these substances.

At the outset a short list of the more important isotopes was drawn up, and it was hoped that an accuracy of the order of 2 per cent would be both adequate and attainable in their standardization. By the end of 1952, samples of ten isotopes had been measured by counting and by ionization-chamber methods. The former included defined solid-angle β-particle counting with end-window Geiger–Müller

counters, 4π-solid angle β-particle counting with Geiger–Müller and liquid scintillation counters, and βγ-coincidence counting. The samples were solutions prepared and distributed by the Atomic Energy Research Establishment, their activities ranging from about 0·1 to 8 mC. per gm. of solution.

The work has shown that the defined solid-angle method is not satisfactory for absolute measurements, owing to the complex absorption and scattering conditions; it may, however, have a use as calibrated equipment. 4π-counter measurements have, on the whole, been satisfactory; thus sodium-24, phosphorus-32, bromine-82, strontium-90 and gold-198 have given values agreeing within about ±2 per cent; differences of about ±3 per cent have been found with potassium-42, cobalt-60, strontium-89 and iodine-131. Some inconsistencies may have been due to the chemical and other changes occurring during the dilution of solutions to the low level of activity required for the preparation of the sources.

The βγ-coincidence values for sodium-24 and cobalt-60 determined by two laboratories have generally agreed to within ±1 per cent; but for isotopes with more complex modes of disintegration, the differences have been several per cent. There has been a tendency for the βγ-values to be greater than 4π-counter values; for cobalt-60, this may perhaps be due to the absorption of β-particles in the solid material in the source itself. It is hoped that improvements in technique will determine and remove these differences.

The γ-ray ionization measurements have been consistent to within ±1 per cent for sodium-24 and cobalt-60 and ±2 per cent for other isotopes. This method is indirect and involves a number of physical quantities, uncertainties in the numerical values of which preclude strict comparison with the direct-counting methods. However, taking these limitations into account, no serious discrepancies have occurred between the two types of measurement.

Following the measurements of the iodine-131 samples, it was decided to revise the British standard for this isotope[1], and responsibility for its maintenance and the issue of standard samples was undertaken by the National Physical Laboratory. No formal specification of other standards has yet been made. The National Physical Laboratory has, however, begun the periodic issue[2] of phosphorus-32 samples calibrated by the 4π-counter method.

During 1953 the scheme of measurements has been continued with the same group of isotopes, and samples have been interchanged with the U.S. National Bureau of Standards and the Atomic Energy of Canada, Ltd. A report on these measurements will be made in the near future.

[1] Bullard, E. C., *Nature*, **170**, 916 (1952).
[2] *Nature*, **171**, 676 (1953).

NEWS and VIEWS

Zoology and Applied Entomology at the Imperial College, London:

Prof. J. W. Munro, C.B.E.

THE retirement of Prof. J. W. Munro from the chair of zoology and applied entomology at Imperial College of Science and Technology, London, brings to an end a long association with the College. After a period as assistant professor of entomology, he succeeded Prof. F. Balfour Browne as professor of entomology in 1929, and in 1934, on the retirement of Prof. E. W. MacBride from the chair of zoology, he assumed responsibility, as professor of zoology and applied entomology, for teaching and research in zoology as well as in entomology. The appointment of Prof. Munro marked not so much a new phase in the development of the Department as a re-affirmation of the purpose of the College "to give the highest specialized instruction, and to provide the fullest equipment for the most advanced training and research in various branches of science, especially in its application to industry". It is against this background that Prof. Munro's achievements are to be recognized. With foresight and method he brought his experience as a forest entomologist to a different field, that of the study and control of the insect pests infesting stored food and other products, and as an essential part of his provision for the training of applied entomologists he built up during the years preceding the Second World War an extremely active Biological Field Station at Slough. The work carried out there laid a firm foundation for the control of stored products pests, and it was a fitting tribute to him that after the outbreak of war in 1939 the organization passed smoothly and efficiently into new control and became the Pest Infestation Laboratory of the Department of Scientific and Industrial Research.

After the War, undaunted by difficulties, Munro set himself the task of building up another field station, at Silwood Park, fully capable of carrying on the tradition established at Slough. With the heavy responsibilities of his duties as director of the Field Station added to those he bore as head of the Department of Zoology and Applied Entomology, and with the essential burden of maintaining an intimate connexion with industry, it was inevitable that Munro's personal researches should suffer; but it is gratifying that the stimulus and opportunity he gave to others, together with his wise and patient guidance and an outlook which passed beyond the walls of the laboratory, has resulted in a body of original work and endeavour of which he may be justly proud. Throughout the Commonwealth the number of Imperial College-trained field entomologists bears witness to Prof. Munro's success in guiding and promoting the training of his students. He has held the balance fairly between laboratory discipline and field studies, and his students have been able to acquit themselves well in widely differing fields of work. Prof. Munro was made C.B.E. in 1950.

Dr. O. W. Richards

Dr. O. W. Richards, who succeeds Prof. J. W. Munro, is well known as a distinguished entomologist. A graduate of Oxford, he became lecturer in entomology in the Imperial College in 1931, received his doctorate in 1934, and was appointed assistant professor in 1938. For many years he has been closely associated with the activities of the Royal Entomological Society, becoming a Fellow in 1924, secretary during 1937–40, and serving for three terms of office on its Council between 1931 and 1945; he was vice-president in 1935. Richards is perhaps best known for his interest and work on the biology

of the Hymenoptera. He has carried out revisions of hymenopteran genera, and while holding a Leverhulme research fellowship visited British Guiana before the War in pursuit of his studies. A recent book on the social biology of insects testifies to his scholarship. But his interests are wider than this. He has worked on the flour-moth *Ephestia*, on population studies of the grain weevil *Calandra*, and on the butterfly *Pieris* and its parasites. More fundamental than this, he has shown a keen interest in problems of speciation and the mechanisms of evolution. He will bring to his new appointment a wealth of taxonomic and ecological experience, and this, together with the experience gained from his close association with the development and work of the College Field Station, will ensure the continued success of entomology at the Imperial College. With the support of his colleagues in the field of insecticide research, and with the encouragement of physiological studies, the Imperial College will remain an important centre for applied entomology. Biologists will wish Dr. Richards every success in the onerous task of maintaining the high level of attainment achieved by Prof. Munro, and of holding a just balance between the varied activities of the Department of Zoology and Applied Entomology.

Cancer Research in the University of Leeds: Prof. R. D. Passey

After more than a quarter of a century of versatile directorship and distinguished personal research, Prof. R. D. Passey, the first holder of the chair of experimental pathology and cancer research in the University of Leeds, is retiring. Coming from the School of Pathology at Guy's Hospital, in London, which was already notable for the classical researches and prescient writings of the late G. W. Nicholson on tumour formation, Passey brought to his Department in Leeds those attributes of intellectual integrity, critical faculty and a broad biological approach which have distinguished his own researches and shaped the development of his Department. Largely financed by the Yorkshire Council of the British Empire Cancer Campaign, the Department has attained increasing eminence for its contributions to our knowledge of cancer in many and diverse directions. These have included the chemical induction of tumours of the skin, mamma, bladder, liver and connective tissue; the role of hormones in the genesis of tumours of the mamma and testis; the structure, frequency and causation of cancer of the lung; the experimental induction of melanoma; enzymes and tumour metabolism, and the metabolism of chemical carcinogens; the milk factor in mammary tumours in mice, and a search for a similar factor in human material; and the physical and chemical properties of connective tissue which may have a bearing on the invasiveness of cancer. In not a few of these researches Passey himself participated, and to all of them he contributed by his encouragement, his wide biological knowledge, his critical judgment and his love of truth. Of special merit has been his healthy scepticism towards ill-founded claims for the discovery of 'causes' of cancer: for example, he showed that Fibiger's 'Spiroptera cancer' of the stomach in rats was not, in fact, cancer; and he was foremost also in showing that the transfer of tumours by frozen-dried tumour tissue was not due, as Gye claimed, to a causative virus, but to the survival of tumour cells. A scientist cannot but feel satisfaction in having built up from its beginnings a Department with such a record of achievement and with a world-wide reputation as a centre of sound research.

Prof. H. N. Green

Prof. H. N. Green, who succeeds Prof. Passey, has held the chair of pathology at the University of Sheffield, previously held by Sir Howard Florey, for the past seventeen years. During this period several hundred contributions to pathological literature and to that of experimental medicine over a very wide field have emanated from Prof. Green and his staff. His early researches with Sir Edward Mellanby at Sheffield were mainly concerned with nutrition, and he published a variety of papers dealing with diet and infection, diet and pregnancy, and the biochemistry of vitamins A and D. Later, he became a demonstrator in the University of Cambridge and there, while working on bactericidal factors in the blood, became interested in chemotherapy. He has contributed in several papers to our understanding of the mode of action of sulphonamides and related compounds. During the Second World War he was asked by the Medical Research Council, with which he has had long associations, to organize a team for the study of traumatic shock. Clinical investigations led to pure laboratory studies in which the shock-inducing action of adenosine triphosphate was discovered. Green later commanded the British Traumatic Shock Team, 2, R.A.M.C., and directed investigations in battle zones in North-West Europe. All these extensive studies on shock culminated in the book, "Biological Actions of the Adenine Nucleotides", by Green and Stoner (1950). Green was also director of the Sheffield Cancer Research Laboratories; and the Annual Reports to the British Empire Cancer Campaign from 1937 until 1952, and his progressively increasing number of papers in this field, reflect his mounting interest, now demonstrated by his acceptance of the chair of experimental pathology at Leeds, and director of cancer research at both Leeds and Sheffield. Though running a large research and teaching department, Prof. Green has always taken a large part in the medical affairs of the University, the hospitals and the region.

Discovery: Mr. William E. Dick

Discovery, the successful monthly journal of popular science, completes its tenth year of continuous publication in its present form with this month's issue. That there is probably no better journal of its type in the world is entirely due to the efforts of its editor, Mr. William E. Dick. He has run *Discovery* almost single-handed since it was restarted in 1943. (Except for its name, the journal has little resemblance to the pre-war *Discovery*, which was wound up for lack of support in 1939.) Mr. Dick is a biologist by training. He took an honours degree in botany with zoology and geology at the Imperial College of Science and Technology after winning a State Scholarship at the age of fifteen. But this bias is not reflected in the contents of *Discovery*, which cover the whole field of pure and applied science. Through his personal contacts with scientists and science writers, Mr. Dick has moulded *Discovery* into a journal which is entertaining, educational and influential. He has probably done more than anyone to encourage British scientists to explain their researches in a written form understandable to the public.

While not designed as a medium for the publication of original work, *Discovery* has from time to time been first with significant scientific news. It was, for example, among the first to print the disturbing facts about the sulphur shortage. It campaigned—with apparent success—for the appointment of scientific attachés in British embassies and for experiments on the underground gasification of coal. It has campaigned, so far unsuccessfully, for better pay for science teachers. With its vigorous editor and an established readership at home and abroad, *Discovery* can be expected to improve both its circulation and its beneficial influence.

Research in Industry

On November 27 the members of the Advisory Council of Scientific and Industrial Research and the chairmen and directors of some forty research associations of the Department of Scientific and Industrial Research held a conference in London, at which they discussed in private the education of technologists and technicians in Great Britain. At the luncheon given in conjunction with the conference, Sir Ian Heilbron, chairman of the Advisory Council, made public the important news that, subject to Parliamentary approval, the Government has decided to allow the Department of Scientific and Industrial Research to plan its work on a five-year basis, thus giving a continuity and flexibility of policy which the Department has long sought. At the same time the Government is restoring in full the financial cuts made two years ago in the Department's post-war programme for the expansion of its work. After expressing his gratitude to the Government for thus generously implementing the Department's aims, Sir Ian went on to deplore the lack of recognition given by industry in general to the work of scientists and engineers. This is particularly reflected, he said, in the fact that few of the boardrooms in industry contain directors who are persons with high technical qualifications. The other speaker at the luncheon, Lord Woolton, who was deputizing for the Lord President of the Council, stressed the importance of technological education as a key factor in industry and hence of Britain's ability to keep its place in overseas markets in the face of rapidly growing foreign competition. He urged that universities, in particular, should not be averse to the giving of academic rewards to students who want to specialize in a technological field to the exclusion of other subjects.

Education in Meteorology

The third annual dinner of the Royal Meteorological Society held on November 20 had this year for its theme "Education in Meteorology", and the guest of honour was Dr. K. W. M. Pickthorn, Parliamentary Secretary to the Ministry of Education. The president of the Society, Dr. O. G. Sutton, in proposing the toast "Education in Science", said that he wonders whether we are not in danger of losing touch with reality by our search for ultimate reality, and whether it would not be worth while to turn some of our attention from the remote, unsubstantial world of atoms and electrons to more friendly and familiar things, to the clouds and the rain and the skies. Meteorology, which has been so neglected in British universities (with certain exceptions), might well, in his opinion, provide the necessary relief from over-specialization. To be a meteorologist one needs to be a very widely read scientist, for there is scarcely any branch of physics which is not involved in meteorology—it even touches on life itself.

Dr. Pickthorn pointed out that there seems to be broad divisions among school-children between born scientists, who would pursue a scientific career irrespective of their schooling, those who would never become scientists, and a very considerable intermediate body who ought to be scientists and could be, given proper training. He believed that, in teaching science, laboratory work could be supplemented by meteorological observations, and he thought that even the quite unscientific might be given some notion of how scientists think and work if their interest in the weather could be exploited. Sir Charles Morris, vice-chancellor, University of Leeds, contrasted the positions of pure and applied science in the United Kingdom and stressed the difficulty experienced in attracting students of sufficient calibre towards research in applied science. He felt that the Royal Meteorological Society by its very closeness to Nature could do a great deal in correcting this bias. Appreciation was expressed by Dr. John Brown, chief education officer of the London County Council, for the Society's Popular Lecture, arranged each year for the benefit of sixth-form pupils. The application for tickets this year has been so heavy that a repeat lecture will be given in the County Hall Lecture Theatre.

Science Masters' Association : Annual Meeting

The annual meeting for 1954 of the Science Masters' Association will be held in Oxford during December 29, 1953–January 1, 1954, under the presidency of Sir Cyril Hinshelwood. The meeting will open with Sir Cyril's address, given at 8 p.m. on December 29, his theme being "Thoughts on the Evolution of a Scientific Problem". On the following day, J. P. Stephenson and R. Thurlow will demonstrate experiments, afterwards on exhibition in the Clarendon Laboratory, at a lecture entitled "Experiments in Elementary Physics", which will be of special interest to those teaching in secondary modern schools. On December 31 the annual business meeting of the Association will be held ; in the late afternoon the Association's report on "The Teaching of Science in Secondary Modern Schools" will be introduced by some of the members of the committee responsible for the report and will afterwards be critically reviewed by a headmaster of a secondary modern school. Each morning at 10 a.m. there will be three simultaneous lectures on biology, chemistry and physics, respectively ; in addition, it will be possible to visit laboratories in the University and discuss problems with the University staff. The afternoon visits will be made to places of interest in Oxford and farther afield. Three exhibitions will be held concurrently with the meeting : in the Dyson Perrins Laboratory the usual exhibitions of apparatus and books by manufacturers and publishers ; in the Inorganic Chemistry Laboratory the usual members' exhibition of apparatus and teaching aids ; and, also in the Inorganic Chemistry Laboratory, a special exhibition by the Scientific Department of the National Coal Board showing the biological, chemical and physical apparatus and research experiments (with demonstrations) used in the routine and the research laboratories of the Department. Accommodation is available during the meeting at Keble College. Further information can be obtained from the annual meeting secretary of the Association, W. G. Rhodes, Park View, 318 Granville Road, Sheffield 2.

University of Glasgow

Mr. Harold J. Trump has been appointed director of extra-mural studies in the University of Glasgow, in succession to the late Dr. W. S. Evans. Lecturers, in the subjects as shown, have been appointed in the University as follows: *Senior Lecturer*, Dr. Ian M. Dawson (electron microscopy); *Lecturers*, R. Common (geography), R. H. Cummings (geology), B. E. L. Deckker (mechanical engineering), W. M. Fairbairn and A. Geddes (mathematics), A. Fraser (agricultural zoology), K. M. Guggenheimer (natural philosophy), R. G. Hemingway (agricultural chemistry), G. W. Hutchinson (experimental physics), J. J. Lewis (pharmacology), Alfred Marr (veterinary medicine), R. G. Moorhouse (theoretical physics), G. H. Nancollas (chemistry, in succession to the late Dr. J. C. James), and J. E. Tinne (bacteriology). In the Department of Natural Philosophy, the following appointments have also been made: A. H. De Borde and Derek Oldroyd (Nuffield Fellows) and W. G. V. Rosser (D.S.I.R. Research Fellow). For the present session 259 new students have been admitted to the Science Faculty of the University (198 men, 61 women); the total number of students registered in the University as a whole is 5,586 (4,364 men, 1,222 women).

Colonial Service: Recent Appointments

The following appointments have recently been made in the Colonial Service: R. B. Jagoe (senior botanist, Federation of Malaya), chief research officer, Federation of Malaya; L. H. N. Larter (botanist, Department of Agriculture, Federation of Malaya), senior botanist, Department of Agriculture, Federation of Malaya; J. C. Parisinos (temporary agricultural superintendent, Class 1, Cyprus), agricultural officer, Class 2, Cyprus; A. W. Burtt (chief chemist, Singapore), director of chemistry, Federation of Malaya; C. Cairns (assistant conservator of forests, Federation of Malaya), conservator of forests, Federation of Malaya; E. J. Strugnell (conservator of forests, Federation of Malaya), deputy director of forestry, Federation of Malaya; W. A. Dos Santos (pathologist, grade *B*, Trinidad and Tobago), pathologist, grade *A*, Trinidad and Tobago; W. G. Barnard (principal veterinary officer, Swaziland), deputy director of veterinary services, Tanganyika; E. C. S. Dawe (deputy director of veterinary services, Tanganyika), director of veterinary services, Tanganyika; Che Mohd Harun bin Taib (extra assistant conservator of forests, Federation of Malaya), assistant conservator of forests, Federation of Malaya; L. Humphrey (senior assistant meteorological officer, Gold Coast), senior meteorological officer, Gold Coast; P. W. A. Davies and J. A. N. Wallis, agricultural officers, Kenya; M. J. Hannagan, agricultural officer, Tanganyika; A. R. Humphrys, agricultural officer, Uganda; T. Tait, agricultural officer, Nigeria; D. R. Williams, animal geneticist, Department of Agriculture, Nigeria; G. Youatt, chemist, Agricultural Service, Federation of Malaya; D. A. Jones, field geologist, Sierra Leone; J. E. Mason, geologist, Somaliland Protectorate; G. T. Wood, geologist, Federation of Malaya; C. A. C. Mims, medical research officer, grade 3, East Africa High Commission; B. D. Rennison, zoologist, East Africa Tsetse and Trypanosomiasis Research and Reclamation Organization, East Africa High Commission; D. G. Cochrane, scientific officer, East Africa High Commission.

Announcements

Mr. Edward Giles Griffiths has been appointed agricultural adviser to the United Kingdom High Commissioner in New Zealand, in succession to Mr. Donald S. Hendrie, who is returning to the United Kingdom. Mr. Griffiths is a graduate of King's College, Newcastle upon Tyne (University of Durham), where he was also awarded the Nathaniel Clark Scholarship. Since May 1949 he has been assistant county agricultural officer (advisory) to the Norfolk Agricultural Executive Committee. He was a member of the Anglo-American Productivity Team that went to the United States in 1950 to study productivity in farming.

A conference on the North Sea floods has been arranged by the Institution of Civil Engineers, and will be held at the Institution during December 16–17. Twelve papers will be presented for discussion. Those who are not members of the Institution may attend the conference provided they have made prior application to the Secretary of the Institution at Great George Street, Westminster, S.W.1, from whom further information can be obtained.

The Massachusetts Institute of Technology is offering a small number of scholarships to university graduates in science, technology and architecture to enable them to attend the summer session of the Institute during June 6–September 18, 1954, for the purpose of carrying out research. The scholarships are open to British citizens less than thirty-two years of age, who have had at least two years experience in postgraduate research, either industrial or academic. Application forms, to be completed by January 4, can be obtained from the Cultural Affairs Officer, Room 302, 41 Grosvenor Square, London, W.1.

Under the provisions of the Fulbright Programme, travel grants are available to citizens of the United Kingdom and British Colonies to go to the United States for an academic or educational purpose, provided that they have the financial support in dollars for the visit and are affiliated to an American institution of higher learning. The grants cover the cost of direct travel from the candidate's home to America and return, and are available during June 1, 1954–April 1, 1955. Applications must be submitted by March 15, 1954 (for those travelling between June 1 and July 31) or June 1 (for those travelling after August 1). Further information can be obtained from the United States Educational Commission in the United Kingdom, 55 Upper Brook Street, London, W.1.

The Royal Aeronautical Society is reviving its previous custom of holding an annual juvenile lecture, which this year will be by Sir Leonard Bairstow, speaking on "The Fun of Finding Out in Flying". The lecture will be given at 3 p.m. on January 7 and will be free. Tickets can be obtained from the Secretary, Royal Aeronautical Society, 4 Hamilton Place, London, W.1.

Erratum. In the communication entitled "Fine Structure of the Extra-terrestrial Radio Source Cygnus I" by R. C. Jennison and M. K. Das Gupta in *Nature* of November 28, p. 996, the measurements illustrated as 51′ (twice) and 30′ (twice) in Fig. 2 should read 51″ and 30″; these are correctly quoted in the text.

DYEING AND TANNING

THE Faraday Society held a General Discussion on "Dyeing and Tanning" in Leeds during September 8–10 under the chairmanship of the president of the Society, Sir Hugh Taylor. The Discussion was well attended and included a number of distinguished foreign visitors. The introductory lecture was given by Sir Eric Rideal, and, in all, twenty-two papers were read; these will be published in due course by the Society.

The picture of the theoretical aspects of dyeing and tanning arising out of the meeting showed that, while the general nature of these processes is well understood, a great deal of detail still requires filling in. This is especially true of tanning, where the nature of the natural tanning material is so complex. The points of interest arising from the two different subjects are best treated separately.

Dyeing Processes

The mode of attachment of the dye is still a subject for speculation and may range from a straightforward partition in the case of non-ionic dyes, or Donnan distribution for ionic dyes, to adsorption on specific sites, the extreme case being Langmuir adsorption. Non-ionic dyes absorbed by cellulose acetate and polyethylene terephthalate are examples of the former, and it was shown that the addition of benzoic acid alters the equilibrium partitions ratio. On the other hand, in the case of wool, resolution of optical antipodes on adsorption shows that specific sites must exist although, as the adsorbed molecule becomes larger, the resolution becomes less. Prof. W. Bradley interpreted this as due to a lower tendency for the larger molecules to be adsorbed on sites. There is, of course, a great deal of evidence to show that sites can exist. Both on synthetic and natural fibres in acid dyeing, the total dye uptake is stoichiometric with certain 'active' groups. The importance of the effect of the fibre constituents on fibre structure as well as their chemical nature, however, was emphasized by Dr. C. H. Bamford *et al.*, who have examined the dyeing behaviour of a number of synthetic polypeptides. The use of the surface balance, too, was described to demonstrate interaction between active groups in dyes and fibres, and on a similar topic Dr. Conmar Robinson demonstrated on the macro-scale stereochemical effects with an ingenious modification of the Stuart-type model. This allows a limited amount of deformation of the bonds such as does actually occur. One striking example was the easy manner in which one may be misled as to the stereochemistry of the adsorption of an azoic dye on cellulose.

So far as the equilibrium of adsorption is concerned, it appears that there is little to choose between the various theories on fundamental grounds because of the difficulty in devising critical experiments, and a choice is usually made on the grounds of expediency. One of the main obstacles is lack of knowledge of the state of the dye in solution. Thus R. H. Blaker *et al.*, in considering the adsorption of acid dyes by coppered polyacrylonitrile fibre, postulate a variation of the activity coefficient by a factor of 600; A. N. Derbyshire and W. J. Marshall, in attempting to measure thermodynamic changes by direct thermal measurement, noted an extraordinarily large heat change on dilution of orange II (normally considered a non-aggregating dye), and Dr. A. B. Meggy described experiments on partition measurements and the effect of sodium sulphate on the solubility of this dye, from which he attempted to gain information on the activity coefficient. Further refinements in the thermodynamic treatment of adsorption data therefore await more complete knowledge of the activity coefficients of dyes in solution.

The rate-controlling steps in dyeing are now fairly well understood in the general sense, and Sir Eric Rideal showed how in many cases the rate of agitation can be a rate-controlling factor due to the relatively large distances the dye must be transported and the low concentration gradient in the external liquid phase. In these circumstances a conventional hydrodynamic flow treatment can be used satisfactorily to determine the thickness of the stationary layer. Diffusion within the fibre is fundamentally more complex, although it appears that the diffusion of acid anions is accompanied by adsorption on fixed sites. R. F. Hudson considers that, when appropriate allowances have been made, the 'free diffusion coefficient' is of the same order as that in water. He also accounted for an observed increase in activation energy with molecular size as due to deformation of the polymer chains by the larger molecules. It is interesting to note that radioactive tracer techniques are being applied to both equilibrium and rate measurements; but on the whole this technique is at present applied only as a refinement on existing ones. An interesting topic in kinetics is a study of absorption of aqueous solutions by dry cellulose, and, although the experimental technique is such that the results cannot be considered as quantitative, such studies must be of great practical and theoretical importance.

Tanning

Tanning is a relatively complex process, and the system presents greater difficulties than dyeing. It is, however, now clear that tanning processes which involve the combination of chrome and other metal complexes depend greatly on the form which the complex takes. K. H. Gustavson showed that the strong reaction of the cationic complexes of chromium is due to an initial adsorption on to single carboxy groups of the collagen, and afterwards the carboxy group enters the chromium complex irreversibly to give a strong covalent linkage. Special considerations, however, make it probable that less than 10 per cent of the total chromium complexes actually form cross-links. The slow nature of the covalent reaction is confirmed by J. Pouradier's study of the interaction of chrome and gelatine whereby he has found that viscosity increases occur over several hours.

The surface balance is being used in tanning as well as dyeing studies. By its means, J. H. Schulman and M. Z. Dogan have examined the effect of *p*H on the cross-linking of various fatty-acid and protein monolayers by a variety of metal ions, while S. C. Ellis and K. G. A. Pankhurst, by the same technique, supplemented by measurements of surface potential charges, have examined the effect of vegetable tannin on collagen monolayers.

One further technique of interest which must be mentioned is that of D. M. B. Armstrong, who described a pyknometric technique of following the diffusion of tannins into hide. In this way he has been able to follow the various steps in the tanning process and show that tanning with tannic acid is much more complicated than with Mimosa tannin.

W. J. Marshall

FIELD STUDIES IN URBAN AREAS

THE Joint Biology Committee consists of representatives of twelve organizations interested in the teaching of biology. It has now held ten public conferences. While the latest, which was held at University College, London, on October 24, and which was well attended, did not contribute much to the solution of the major problem for which it was convened, it threw light on a number of subsidiary issues which merit attention both by teachers and biologists in general.

In his opening address, R. S. R. Fitter said that although the Industrial Revolution might have driven Nature away from urban areas, there has been a vigorous return. Towns provide special opportunities for the study of processes of biological adaptation to changing conditions. He instanced the house-martin and rock pigeon, dwellers of rocky cliffs, that have taken readily to buildings, and the Oxford ragwort, the natural habitat of which is the lava flows of Sicily but which now is equally at home on sites reduced to rubble by air raids. Town sites tend to encourage a pioneer flora; in fact, modern civilization has greatly extended the area open to plants falling into this group, while upon any site the temporary associations so established are themselves subject to rapid change. He suggested that urban areas provide many opportunities for the study of local geology and geography, together with that of certain plant and animal species. He appreciates the limitations imposed by urban conditions; but he is inclined to view them as a challenge, emphasizing that a great deal still has to be learned about the natural history of even such common animals as the starling and house sparrow.

Miss M. Collis dealt with biology teaching in the secondary modern school, selecting for special consideration the claims of children in the *C* and *D* streams who might find it difficult to read and write. Yet work with them she feels to be well worth while. It might begin with sensibly directed observation and collection out of doors, the sorting and disposal in the classroom of the material so collected, leading to further inquiry and exploration and so to the production of records of educational worth. With older pupils the work might be given a more experimental approach, providing further training in the keeping of records while giving the children a clearer conception of the interdependence of living things and the factors that constitute their environment. Miss Hilda Franks, who followed, emphasized that 70–80 per cent of all children pass through secondary modern schools. The teacher's task, she feels, is to put meaning and value into their lives by fostering in them the love of plants and animals. Interest once aroused will provide the basis for more critical standards and so encourage better ways of living. To her it seems that many social ills might be solved through education based on direct contact with real things.

Field studies at grammar schools were discussed by C. T. Prime and W. H. Dowdeswell. Mr. Prime said that at his school, Whitgift, Croydon, biology specialists in the sixth form can elect to take field studies at advanced level in the examination for the General Certificate of Education. Several do so. One difficulty is that the scripts have to be submitted by the beginning of May; another one is that it is not easy for a young investigator to maintain interest in some selected project throughout a whole year. His procedure is to encourage the boys either to make a general biological survey of some fairly restricted area or to set them the task of making a more intensive study of the biology of one or two species of animals or plants. Problems of identification, which are basic, present difficulties, although in his mind they are not insuperable, for several of the smaller groups of animals and plants provide suitable material.

That young biology investigators should not be expected to take on too much was also the opinion of Mr. Dowdeswell. He has found at Winchester College that the survey of a ten-yard stretch of a local stream is the kind of task that they can manage. In his opinion the essential point is to concentrate on ecological principles, which can be brought out from a wide selection of material. He made a special plea for the study of the soil. It is very variable and it lends itself readily to investigation under school conditions. Experiments on its physical nature and mineral composition are comparatively easy to perform, and there are many biotic factors which can be studied in the field and laboratory bringing out the interrelations within the organic complex.

An account of what she is doing at the Children's Centre, and with the Junior Nature Group, at the British Museum (Natural History) was given by Miss J. Palmer. Altogether, during the past five years about three thousand children have passed through her hands, their ages ranging from eight to seventeen with a heavy preponderance around ten and eleven. Three-quarters of the children were boys and a similar proportion were of grammar school standard. Those that visited the Centre were motivated primarily by the urge to collect specimens. She tried to encourage them to draw, paint and model the living organisms in which they were interested and so train them to observe more carefully. Among young children the urge to collect objects is extremely strong, but after twelve it tends to diminish; her aim is to canalize it in the right scientific direction. She is finding that some of her early members are now anxious to remain at the Centre until they reach seventeen, and they are developing into efficient natural historians. While some of the claims made by the children for what they have observed are fantastic, a few are real additions to scientific knowledge.

Several further points emerged from the open discussions. Among those taking part, difficulties over finding time for field-studies were fully appreciated, although they did not always appear to be so by others. Problems concerned with workrooms and other material facilities are not insoluble, given the right kind of teacher, for in the London area education authorities are said to be sympathetic. Nevertheless, it was generally felt that, as was revealed by a recent report issued by the British Association, the field-work done at schools in Great Britain falls far below what is desirable. The lack of field-work is all the more to be regretted because

personal observation has such a favourable influence on what young pupils have to do; in examinations, for example, it is a common experience to find diagrams of plant structure slavishly reproduced from text-books. This brought up the question of training. There was an almost unanimous opinion that university courses in biology are not designed to train teachers for their work, particularly in relation to field studies. Some reform of university courses is essential. Little guidance, too, is forthcoming from the usual type of biology text-book.

As indicated above, the day's proceedings did not do much to help the biology teacher in a grammar school situated in the midst of a thickly built-up area. Certain suggestions were made, but they touched only the fringe of the problem, and it appeared as if the best procedure is to arrange for the pupils to attend short courses at field centres in rural areas. Several speakers commented on the waning of interest in living things among boys and girls in the middle range of grammar schools; they attributed this mainly to the pressure of work in preparing for the General Certificate of Education. No comment, however, was made by teachers on the field studies carried out by young people as a purely voluntary, spare-time activity, particularly during the holidays. Studies of this nature may be fostered by school natural history societies. They bring out certain special educational considerations since they are personal and not directed. They are also the purest source of natural history. R. WEATHERALL

POLISH MATHEMATICAL CONGRESS

THE eighth Congress of Polish Mathematicians was held in Warsaw during September 5–12, and was attended, by invitation, by about forty-two mathematicians from outside Poland. There were two British mathematicians present.

The main sections of the Congress were concerned with mathematical logic; the theory of probability and its applications to statistics; modern mathematical methods, especially those of functional analysis and topology and their application to the classical theory; and the role of mathematics in physics and technology. In addition to the main conferences, held mostly in the morning, there were many sections at which short papers were read.

It is interesting to recall the salient features of the Polish school of mathematics. Before the Second World War this school had two main centres, in Warsaw and Lwów respectively. The Warsaw school was occupied largely with the theory of sets and with mathematical logic, and it was in these two branches that it had its greatest achievements. We owe to the Polish set theorists, in particular, some very beautiful theorems on the topology of the plane, such as the extension to certain classes of continuous functions of a form of Weierstrass's theorem on the decomposition of an integral function into primary factors, and Rouché's theorem on the zeros of a holomorphic function inside a closed contour. These extensions have thrown new light on the topological character of these theorems on functions of a complex variable. The Polish school of mathematical logic is perhaps even better known, for the contributions of Polish mathematicians stand out in practically every branch of this subject.

The most outstanding contributions of the Lwów school were in the domain of functional analysis, with which the name of Banach is so intimately associated. It was Banach's work which laid the foundation for so much of modern analysis, and with his death, in the summer of 1945, the world lost a great mathematician. Under his guidance the mathematical life in Lwów, in the years before the War, was very free and friendly, with mathematical discussions taking place frequently in cafés. One of Banach's institutions was what became known as the "Scottish Book"—a book of problems contributed by the Lwów mathematicians, and any others who happened to be visiting Lwów. It was kept in a café frequented by mathematicians, after which it became known. The result was a very interesting collection of mathematical problems. It has survived the War, and a new "Scottish Book" has been started at Wroclaw, where the Lwów Institute has been re-established.

Polish mathematicians suffered enormous losses during the War. Some fifty-four lost their lives, very many in almost unbelievable circumstances, a loss which represented a ratio of about one in four. Immediately after the Nazi invasion those of Jewish descent were declared outlaws. This meant that some were shot almost at once, while others managed to survive in hiding until the summer and autumn of 1943, when they were either shot by the Gestapo or sent to the gas chambers. Saks, Schauder, Auerbach, among very many others, perished in this way. Banach and Mazurkiewicz both died within a few months of liberation. Very many of those who died were young men who had yet to make their full contribution to mathematics, and their loss to Polish mathematics is incalculable. Lives lost cannot be replaced; but every effort has been made during the past eight years to do whatever possible to build up the school again. Generous government grants have enabled the various mathematical institutes to re-establish themselves as research centres. At present they are maintaining three journals of international standing, and several others primarily for circulation in Poland. They are also re-issuing the series of "Mathematical Monographs".

The Congress brought out three things very clearly: first, the remarkable continuity in the Polish school; second, the contributions being made by the younger Polish mathematicians, who have grown up in the years since the War; and third, the desire of all for the better exchange of scientific work. It is true that the work of several of the younger men is already known in Great Britain, but more contact is needed between British and Polish mathematicians. Before the War this was partly achieved as a result of the unfortunate necessity for many Poles to seek posts outside Poland. To-day there are plenty of posts for mathematicians in Poland, and other and happier ways must be found for securing scientific co-operation. It would, for example, be very valuable if some Polish mathematicians were to come to Britain to lecture and hold seminars. Assurances were given at the Congress that for their part they would be very pleased to do so, for they are anxious to develop scientific contact with British mathematicians and would, in particular, welcome suitable papers in their journals.

Polish mathematics has a great tradition, and one peculiarly its own, and it is heartening to know that this famous school is re-establishing itself.

ROYAL GREENWICH OBSERVATORY

ANNUAL REPORT FOR 1952–53

THE annual report of the Astronomer Royal for the period May 1, 1952–April 30, 1953*, following the scheme of previous reports, deals with three separate sections of the Royal Greenwich Observatory, at Herstmonceux (including H.M. Nautical Almanac Office), Greenwich and Abinger. The recommendation of the Board of Visitors about the old buildings of the Royal Observatory at Greenwich, to which reference was made in the annual report for 1951–52 (see *Nature*, **170**, 1111; 1952), has been carried out; the Octagon Room was formally opened by H.R.H. the Duke of Edinburgh on May 8, and is now accessible to the public at regular museum hours. The Time Ball was brought into operation again on October 26 and has since been dropped at 1 p.m. daily, with occasional exceptions. The removal of books from the Library to Herstmonceux was nearing completion at the time of the visitation, and some of the shelving had also been moved to the huts at Herstmonceux, to be used for storing some of the contents of the Greenwich Record Rooms.

Large variations in the voltage of the mains electricity supply at Abinger have been responsible for considerable inconvenience to the operational work of the Time Service and, pending modification in the supply arrangements, a static balancer has been temporarily installed. At Herstmonceux there has been satisfactory progress in various structural alterations, lighting, etc., and the foundations for the control building for the photographic zenith tube have been completed. Contracts have been let for the manufacture and erection of the buildings to house the Cooke reversible transit circle, the photographic zenith tube, and the Bamberg small transit; the expected completion dates of these buildings will be greatly delayed, but it is hoped that they will all be erected by the end of the year.

The Ordnance Survey is to fix a datum point in a position that has been selected to the south of the site for the Isaac Newton telescope. The position of the base plate of the Cooke reversible transit circle, when it has been placed in position and before the erection of the walls of its housing, will be determined relative to the datum point. An accurate geodetic connexion between the Cooke reversible transit circle at Herstmonceux and the Airy transit circle at Greenwich can thus be derived. It is satisfactory to know that the working drawings for the equatorial group of instruments have been completed and that it may be possible before the end of the summer to accept tenders for the steel work.

It is only possible in this limited space to refer to a few matters of outstanding interest or importance. Among the former, attention may be directed to the fact that facilities have been granted at Herstmonceux to members of the Atomic Energy Research Establishment, Harwell, for the investigation of the recently discovered light flashes in the sky. It is believed that these short bursts of light are Čerenkov radiation from cosmic rays in the atmosphere. Observations with a photoelectric recording unit installed in the solar dome are already being made by members of the Establishment and of the Observatory; but during the summer months these tests are discontinued owing to the short period of total darkness during the nights.

Experiments have been made at the outside broadcast headquarters of the B.B.C. Television Service at Wembley on televising the disk of Jupiter, using a 14-in. reflecting telescope fed by a coelostat. With the very sensitive photocathodes used in modern television cameras, promising results were obtained, and it was proposed to attach such a camera to the Yapp reflector during the autumn to show Jupiter in short astronomical programmes.

As foreshadowed in last year's report, a substantial reduction in the staff of the Nautical Almanac Office has been possible through the concentration of routine computing on the punched-card machines. This reduction has been effected by leaving vacancies unfilled and also by transferring some members of the Nautical Almanac staff to other departments of the Observatory. In the account of the work of the machines, which is given in the report, the large amount of work that has been accomplished is summarized, and, speaking of one particular undertaking, the report says: "This last job has proved peculiarly suitable for punched-card methods . . .; it is difficult to see how this work, involving the formation, checking, and summation in groups, of some four million terms, could otherwise have been done, except on an electronic machine".

It is satisfactory to notice that the report ends with an optimistic outlook—different from that of some of the reports issued in recent years—and it is hoped that the removal of the Observatory to Herstmonceux will be substantially complete by the end of 1956.

* Report of the Astronomer Royal to the Board of Visitors of the Royal Greenwich Observatory, read at the Annual Visitation of the Royal Observatory, June 13, 1953. Pp. 30. (Greenwich: The Observatory, 1953.)

RESEARCH AND DEVELOPMENT IN BRITISH COLONIAL TERRITORIES

THE now customary annual review of events and developments in British Colonial and Protected Territories is provided in the report entitled "The Colonial Territories 1952–53"*; the survey is of exceptional interest this year on three counts. First, it provides the man of science with the background against which the subsequent report, "Colonial Research 1952–53", will appropriately be considered. The recent statement in the House of Commons by the Colonial Secretary, Mr. Oliver Lyttelton, regarding the forthcoming legislation on Colonial development and welfare funds gives unusual interest to this background for Colonial development in general as well as for Colonial research. It is also of interest in the same way in relation to the proposals for educational development in Africa, alike for suggestions that have come from the report on African education sponsored by the Nuffield Foundation and the Colonial Office or from the Commission on Higher Education for Africans in Central Africa. Moreover, while the review of constitutional and administrative developments is of topical interest in so far as it concerns federation in Central Africa, such political developments cannot be ignored by those concerned with or interested in higher education, for example,

* Colonial Office. The Colonial Territories 1952–53. (Cmd. 8856.) Pp. ix+157. (London: H.M.S.O., 1953.) 5*s*. net.

as has already become apparent in regard to the principal recommendation of the Carr–Saunders Commission.

To the man of science the review is chiefly of interest in that it provides the proper perspective for regarding developments with which he is more intimately concerned. The general survey, which forms Part 1 of the report, brings out the essential relation between the political evolution of the territories and their technical, scientific, medical and social development, and it should contribute both to a wider realization of the extent to which responsibility for self-government in these areas has already been devolved and to the understanding on which responsible criticism, whether in the political or in the technical field, must be based. While prominence is given to constitutional changes—for example, in British Guiana, in Nigeria and in Central Africa—the emphasis of the review lies this year as much on advances in education as on economic matters. The operations of the Colonial Development Corporation and the Volta River aluminium scheme are seen in perspective and also the dependence of the Colonial territories on the continued provision of the funds which have been provided under the Colonial Development and Welfare Acts ; but it is increasingly clear that the crucial factor in political and in economic development is education.

Except Central Africa, all the main Colonial regions now have local universities, and there are 3,464 students enrolled in the seven university institutions, compared with 3,417 in the previous year, while the number of Colonial students in the United Kingdom and Republic of Ireland has risen from 5,150 to 6,300, of which 1,443 hold scholarships. The £6 million originally allocated for higher education under the 1945 Act has been fully committed, but an additional allocation from funds available under the 1950 Act is making possible the completion of some of the capital programmes which had to be seriously curtailed because of rising prices, and also the financing of some of the most urgently needed new developments at existing institutions. Besides a further £750,000 towards the cost of the new teaching hospital, the Nigerian Government has given £1·5 million to University College, Ibadan, as an expendable endowment over fifteen years, and £300,000 for capital expenditure. The Gold Coast Government is unable at present to embark on the establishment of a medical school at the University College of the Gold Coast. A welcome development at Makerere College, the University College of East Africa, has been the substantial proportion of students completing their preliminary science training whose first preference is the agricultural course. A warm tribute is paid in the report to the help given to these young university colleges by the University of London.

In higher technical education the Gold Coast College of Technology, Science and Arts at Kumasi was able to admit 450 students to courses starting late in 1952 and in January 1953. The Nigerian College of Arts, Science and Technology was established in May as an autonomous institution with branches at Ibadan, Zaria and Enugu, with the main branch at Zaria, and the original allocation of Colonial Development and Welfare Funds was increased to £600,000. The appointment of a principal designate of the Government Technical Institute enabled the Sierra Leone Government and the Fourah Bay College to co-ordinate plans for the development of technical education generally. Tribute is paid to the Nuffield Foundation for its help in financing the survey of education in West and in East and Central Africa by two study groups, the reports of which were discussed at a subsequent conference in Cambridge, and attention is directed to signs of increasing recognition of the importance of the education of girls : for example, the first government boarding school for girls in Somaliland was opened during the year, and in Hong Kong a new technical school for girls ; the first Fijian girls have been admitted to the Central Medical School for the Pacific ; and in Mauritius the foundations have been laid of the new building for Queen Elizabeth College, the government girls' secondary school.

The review notes that for the first time for many years health service establishments are up to strength in most territories. The expansion is not always equal to the need, and hospitals, health centres and infant and welfare centres are under heavy pressure. At Singapore, for example, the annual out-patient attendance approaches six hundred thousand compared with ninety thousand before the Second World War. The increased demand for curative services, which is an index of the confidence that has been won during recent years and a contributory factor to the striking improvement in health statistics, involves problems for the Colonial governments in keeping a reasonable balance between curative and preventive services. Increased industrializatio ., with the corollary of migration of labour and the creation of new urban centres, has required careful planning of health services to avert any serious complication, and a spectacular instance has been the eradication for three months of the fly *Simulium damnosum*, the larvæ of which carry the filarial disease known as onchocerciasis, by applying lethal concentrations of DDT to its breeding places over a forty-mile stretch of the Nile. A preliminary entomological survey of the Volta River area has provided the Department of Health of the Gold Coast with much of the information required to minimize dangers to health when the scheme begins to operate. Following the eradication of malaria from Cyprus, the disease has now been almost eliminated in Mauritius, virtually from Singapore, and notable progress is reported in British Guiana and Malaya. The sulphone drugs now in universal use in the Colonial territories hold promise of ultimately eradicating this disease also : of thirty thousand patients receiving treatment in Eastern Nigeria, six thousand were discharged as free of symptoms in 1952. Mastery is also being gained over trypanosomiasis : in Nigeria, while during 1931–40 more than three million people were examined and 395,554 cases treated, during 1946–52, of five and a half millions examined only 73,585 needed treatment, and during 1952 only seven thousand were treated, compared with ninety thousand at the peak. While the disease remains endemic in East and Central Africa, it is considered unlikely that serious epidemics will ever again become established. The outbreak of yellow fever in Nigeria during November 1951 was completely under control early in 1952, and no further cases have been reported there or in Sierra Leone or the Gambia. The last outbreak in the Caribbean area was in 1921 in British Honduras, and the mosquito which carries the disease has been eradicated from Corozal, although still present, in limited numbers, in Belize.

All this has demanded a continued high rate of recruitment to the Colonial Medical Service from the

United Kingdom and other Commonwealth countries, and 147 doctors were appointed in 1952, while there is a steadily increasing number of medical officers of local origin, particularly in the Far East, West Africa, the West Indies, Cyprus and Mauritius. Whereas on January 31, 1953, 638 Colonial students were reading medicine in the United Kingdom and Eire, young men qualifying locally still seemed to prefer private practice to entering government service. An increase in the number of specialist posts has been noticeable, and especially in the fields of radiology, anæsthetics, pathology and psychiatry it has been difficult to fill such posts by recruitment from the United Kingdom. In this section of the report emphasis is once again laid on the dependence of any solid expansion of the health services on the adequate training of sufficient numbers of auxiliary technical, clinical and nursing staff.

The scale of assistance sought by the Colonial territories under the Expanded Programme of United Nations Technical Assistance increased, and among the requests noted are those from the following countries: Tanganyika, three geologists for a mineral exploration team; the Federation of Malaya, an expert in the rehabilitation of the blind, for the training of radio-technicians and for an aero-magnetic survey; Jamaica, a palæontologist; British Guiana, a hydro-electric expert; British Honduras, a rice expert; Kenya, a pineapple canning expert; and the Gold Coast, an expert in mass-education rural training centres. Considerable use is being made by the Colonial territories of the fellowship facilities offered by the United Nations and the Specialized Agencies, and eighty-one such fellowships and scholarships are now held.

The expenditure of £14 million on development and welfare schemes and on research schemes was approximately the same as during 1951–52; but although research schemes are specifically excepted from the statutory time limit, the available funds are already almost fully committed, and it is pointed out that the position will soon be reached when no new long-term projects can be undertaken, in the absence of further funds. The progress in research is reported fully in the subsequent report "Colonial Research, 1952–53", and it will suffice here to note that the West African Governments are considering proposals for the establishment of a West African Agricultural Research Advisory Committee with a permanent secretariat, that the Clove Research Unit in Zanzibar has established the causes of slow-decline, die-back and sudden-death in clove trees, and the Zanzibar Government is planning experiments to control the two fungi which are responsible for these diseases. The recruitment of field staff for geodetic and topographical surveys in the Colonial territories did not keep pace with resignations or transfers, but prospects of recruitment of field surveyors and other technical staff are now much better, and the total staff is expected to be increased by more than fifty during 1953–54. The overseas scientific staff of the Colonial Geological Surveys increased from 180 to 190 during 1952, and the universities continued to show their interest in the geology and natural resources of the Colonial territories.

Besides the expenditure from Colonial Development and Welfare Funds (which included replenishment of the central allocation for broadcasting by £250,000 to complete the programme of capital equipment, and of that for Students' Welfare by £284,000 to permit continuance of existing services to March 31, 1956), approximately £25,250,000 was expended on the Colonial territories from the Vote for Colonial and Middle Eastern Services in 1952–53, part of this being grants for the repair of damage and for rehabilitation or reconstruction in the West Indies caused by earthquake, hurricane, flood or fire. Although the large financial contribution which the United Kingdom is making to Colonial development and welfare is fully displayed in this survey, it is equally pointed out how such developments depend upon closer co-operation and understanding between the United Kingdom Government and those of the Colonial territories, between the several departments concerned (for example, eradication of the tsetse-fly has required the co-operation of every field department of the Colonial governments), between local and overseas staff and between government and the people served. The educational developments recorded in this report are clearly contributing both to the supply of leaders able to fulfil their new and growing responsibilities with the goodwill and judgment that the present leaders, on the Gold Coast and elsewhere, are manifestly striving to show, and also to the training of a community able and willing to co-operate. The existence of a like goodwill on the part of the United Kingdom is also recorded, which joined to imagination could well make partnership a reality and no more a pious sentiment.

URIDYL TRANSFERASES AND THE FORMATION OF URIDINE TRIPHOSPHATE*

Enzymic Production of Uridine Triphosphate: Uridine Diphosphoglucose Pyrophosphorolysis

IN the present communication we wish to describe a hitherto unrecognized pathway by which uridine triphosphate can be formed. We have previously reported[1] that dialysed yeast maceration juice contains an enzyme which in the presence of uridine diphosphoglucose[2] brings about an incorporation of inorganic pyrophosphate labelled with phosphorus-32 into a uridine nucleotide with simultaneous splitting-off of glucose-1-phosphate. This enzyme, which we called uridine diphosphoglucose pyrophosphorylase[3] (in analogy with other pyrophosphorylases), does not in any detectable way attack other known uridine diphosphoglycosyl compounds. However, it has been shown recently[4] that a suspension of rat liver nuclei pyrophosphorylates uridine diphosphate-N-acetylglucosamine as well as uridine diphosphoglucose.

The specific uridine diphosphoglucose pyrophosphorylase is present in *Zwischenferment* preparations[5,6], particularly in the fraction precipitated by between 60 and 70 per cent saturated ammonium sulphate. If phosphoglucomutase and triphosphopyridine nucleotide are added, the liberation of glucose-1-phosphate from uridine diphosphoglucose can be followed[5] at 340 mμ. For each mole of pyrophosphate incorporated into the nucleotide, one mole of α-glucose-1-phosphate is liberated. A demonstration

* These investigations were supported by grants from Carlsbergfondet, Rockefeller Foundation, Lederle Laboratories Division of the American Cyanamid Co. and Istituto Sieroterapico Italiano.

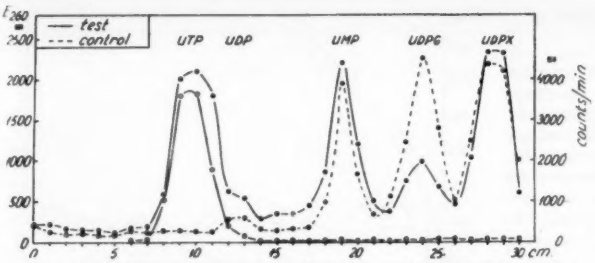

Fig. 1. Paper chromatogram of norite eluate from uridine diphosphoglucose pyrophosphorylase digest

Abscissa: distance from starting line in cm.; ordinate: extinction × 10^3 at 260 mμ.

Reaction mixture: 0·2 μmol. uridine diphosphoglucose; 2 μmol. inorganic pyrophosphate (8 × 10^4 counts/min.); 50 μl. *Zwischenferment* (3 mgm./ml.); 3 ml. *M*/10 *tris*-hydroxymethyl amino methane hydrochloride, *p*H 8·0; *M*/100 magnesium chloride. Control mixture: same without pyrophosphate.

After 45 min. incubation the digests were acidified, adsorbed on norite and eluted with 50 per cent ethanol. Chromatographed 44 hr. in neutral solvent (ref. 9). Chromatogram scanned in the Beckman spectrophotometer at 260 mμ and in the Geiger counter

and purification of the new nucleotide, which was suspected to be uridine triphosphate, can be carried out on a microscale as described in Fig. 1. The nucleotide can also be isolated from a 'Dowex Cl' column by elution with 0·2 *M* sodium chloride in 0·01 *M* hydrochloric acid; other uridine compounds, including uridine diphosphate, can be eluted with 0·1 *M* sodium chloride in 0·01 *M* hydrochloric acid. The molar ratio of uracil, estimated at 260 mμ, to radioactive pyrophosphate was found to be 1·18 (calculated for uridine triphosphate, 1·00); total phosphorus/uracil was 2·7 (calculated for uridine triphosphate, 3·0).

Uridine triphosphate is active in two reactions in which the diphosphate was completely inactive. The first reaction is the phosphorylation of glucose[7] via adenosine diphosphate, which is described in a separate communication[8]. This reaction, in which uridine triphosphate and adenosine diphosphate react to form adenosine triphosphate, which then phosphorylates glucose, has been used to assay

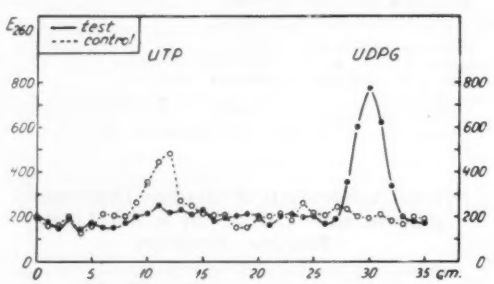

Fig. 2. Paper chromatogram of norite eluate from uridine triphosphate pyrophosp .orylase digest

Abscissa: distance from starting line in cm.; ordinate: extinction × 10^3 at 260 mμ.

Reaction mixture: 0·2 μmol. uridine triphosphate; 10 μmol. α-glucose-1-phosphate; 100 μl. inorganic pyrophosphatase; 50 μl. *Zwischenferment* (3 mgm./ml.); 1 ml. *M*/10 *tris*-hydroxymethyl aminomethane hydrochloride, *p*H 8·0; *M*/100 magnesium chloride. Control mixture: same without α-glucose-1-phosphate

After 50 min. incubation, the digests were acidified, adsorbed on norite and eluted with 50 per cent ethanol. Chromatographed 44 hr. in neutral solvent (ref. 9). Chromatogram scanned in the Beckman spectrophotometer at 260 mμ.

In the norite filtrates, inorganic phosphate was precipitated as magnesium–ammonia salt, washed with dilute ammonia and dissolved in 150 μl. 0·2 *M* sulphuric acid. Counting the samples in the Geiger counter gave the following results, expressed as counts per min.: control, 186; test, 3,660

uridine triphosphate. It has then been possible to determine that an hour's exposure to 0·01 *M* mineral acid at 100° C. brings about a 50 per cent hydrolysis of uridine triphosphate.

In the second reaction, uridine triphosphate as well as uridine diphosphoglucose act as uridyl donors, that is, the so-called uridine diphosphoglucose pyrophosphorylase could also be called a uridyl transferase and the action could be formulated as follows:

UDPGlucose + pyrophosphate ⇄
UTP + α-glucose-1-phosphate.

The reaction from left to right has been described briefly[1]. The reverse reaction, that is, formation of uridine diphosphoglucose from uridine triphosphate and α-glucose-1-phosphate, has been followed, using uridine triphosphate labelled with phosphorus-32 (uridine-P-^{32}P-^{32}P) and converting the inorganic pyrophosphate generated to orthophosphate by means of a specific pyrophosphatase for inorganic pyrophosphate. The results of a typical experiment are illustrated in Fig. 2.

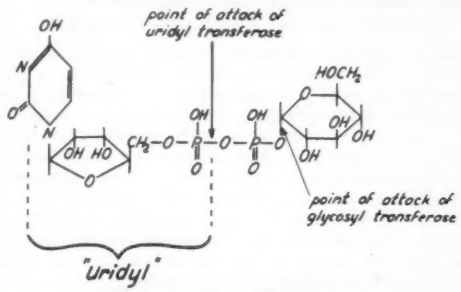

Fig. 3. Uridine diphosphoglucose

In accordance with observations made on the pyrophosphorolysis of uridine diphosphoglucose, the reaction can therefore be expressed according to the reaction written above. The enzyme catalysing this process in both directions could consequently be classified as a uridyl transferase with inorganic pyrophosphate or α-glucose-1-phosphate as uridyl acceptor. The location of fission by the transfer reaction can be illustrated by the formula shown in Fig. 3. The following communication illustrates that there exists at least one more acceptor for this type of reaction: α-galactose-1-phosphate.

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Uridyl Transferases and the Formation of Uridine Diphosphogalactose

Leloir and co-workers have shown that uridine diphosphoglucose is the coenzyme of the enzymic conversion of α-galactose-1-phosphate to α-glucose-1-phosphate in galactose-adapted yeast, *Saccharomyces fragilis*[1]. Leloir has demonstrated directly the presence of an inversion enzyme (*Galactowaldenase*) in *S. fragilis* which catalyses the equilibrium uridine diphosphoglucose ⇄ uridine diphosphogalactose in which 75 per cent exists in the glucosyl form and 25 per cent in the galactosyl form[2].

We have found two other reactions which result in the formation of uridine diphosphogalactose. The first reaction is between uridine triphosphate and α-galactose-1-phosphate and takes place in the presence of a dialysed extract of *S. fragilis* :

UTP + α-galactose-1-phosphate ⇄
UDPGalactose + α-glucose-1-phosphate. (1)

The second reaction, which can be demonstrated in extracts of *S. fragilis* which have lost the inversion enzyme by standing, is a direct exchange between uridine diphosphoglucose and α-galactose-1-phosphate :

UDPGlucose + α-galactose-1-phosphate ⇄
UDPGalactose + α-glucose-1-phosphate. (2)

In the presence of phosphoglucomutase, *Zwischenferment* and triphosphopyridine nucleotide, uridine diphosphoglucose is consumed stoichiometrically and the uridine diphosphoglycosyl compound formed does not react when incubated with uridine diphosphoglucose pyrophosphorylase, inorganic pyrophosphate, *Zwischenferment* and triphosphopyridine nucleotide[3].

That this reaction is a direct exchange incorporation (Leloir's first equation[2]) and involves no pyrophosphorolytic mechanism is emphasized by the fact that the reaction proceeds in the absence of inorganic pyrophosphate and even in the presence of inorganic pyrophosphatase. Reactions (1) and (2) can be demonstrated when to a fresh, dialysed extract of *S. fragilis* is added uridine triphosphate, α-galactose-1-phosphate and triphosphopyridine nucleotide. Under these conditions, an amount of glucose-6-phosphate (detected by the measurement of reduction of triphosphopyridine nucleotide at 340 mμ) is formed which is at least three times the amount of uridine triphosphate added (Fig. 1). This is due to the following sequence of reactions, which is catalysed by enzymes all present in dialysed *S. fragilis* extracts :

(*a*) UTP + galactose-1-phosphate →
UDPGalactose + pyrophosphate
(*b*) (Pyrophosphate + H_2O → 2 orthophosphate)
(*c*) UDPGalactose → UDPGlucose
(*d*) UDPGlucose + galactose-1-phosphate →
UDPGalactose + glucose-1-phosphate
(*e*) Glucose-1-phosphate → glucose-6-phosphate
(*f*) Glucose-6-phosphate + TPN^+ + H_2O →
6-phosphogluconic acid + TPNH + H^+

Incubation of the *S. fragilis* extract with each component separately does not yield glucose-6-phosphate.

The fact that not only uridine diphosphoglucose and uridine diphosphogalactose but also uridine tri- and even di-phosphate + adenosine triphosphate[4] can act as inversion coenzyme (*co-Waldenase*) makes the *co-Waldenase* assay less specific for certain purposes in which a biological identification of uridine diphosphoglucose, for example, is wanted. For such bioassays the specific uridine diphosphoglucose pyrophosphorylase in *Zwischenferment*[3] seems, for the time being at least, the most suitable tool.

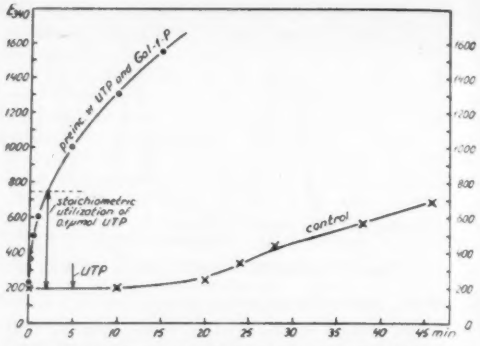

Fig. 1. Spectrophotometric analysis (reduction of triphosphopyridine nucleotide) of glucose-6-phosphate from uridine triphosphate and α-galactose-1-phosphate in *S. fragilis* extracts
Abscissa : time in minutes ; ordinate : extinction × 10^3 at 340 mμ.
Reaction mixture : 0·1 μmol. uridine triphosphate, 0·6 μmol. α-galactose-1-phosphate (by courtesy of Prof. L. Leloir and Dr. J. Reissig, Instituto de Investigaciones Bioquimicas, Fundacion Campomar, Buenos Aires ; barium salt, subjected to reprecipitation with ethanol, acid-labile phosphate estimated), 50 μl. dialysed *S. fragilis* extract (approx. 25 μgm. protein), 500 μl. 0·1 *M* tris-hydroxymethyl aminomethane hydrochloride, *p*H 8·0, *M*/100 magnesium chloride.
Control mixture : same, without uridine triphosphate.
After 30 min. incubation, excess of triphosphopyridine nucleotide was added (time zero on the graph). At 5 min., 0·1 μmol. uridine triphosphate was added to the control

Uridine diphosphogalactose can thus apparently be formed in three different ways : (i) enzymic inversion of uridine diphosphoglucose (catalysed by galactowaldenase) ; (ii) enzymic transfer of uridyl from glucose-1-phosphate to galactose-1-phosphate ; and (iii) enzymic transfer of uridyl from pyrophosphate to galactose-1-phosphate.

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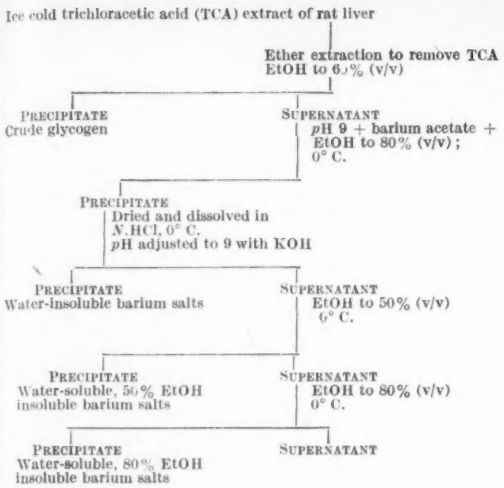
Pyrophosphorolysis of Uridine Diphosphoglucose and 'UDPX' by a Rat Liver Nuclear Fraction

A uridine diphosphoglycosyl compound, chromatographically identical with the 'UDPX' factor obtained by Paladini and Leloir[1] from yeast, has been isolated from rat liver as indicated in the accompanying scheme [p. 1039]. The 80 per cent ethanol insoluble barium fraction so isolated contained approximately 50 per cent adenosine monophosphate, 20 per cent uridine monophosphate and 30 per cent 'UDPX' as determined chromatographically. Separation of the pure 'UDPX' was achieved by paper chromatography using the ethanol–ammonium acetate solvent (*p*H 7) of Paladini and Leloir[1].

In common with the 'UDPX' obtained from yeast, that from rat liver does not undergo pyrophosphorolysis to uridine triphosphate in the presence of



inorganic pyrophosphate labelled with phosphorus-32 and *Zwischenferment* preparations[2]. However, in the presence of a rat liver nuclear fraction isolated by the method of Hogeboom and Schneider[3], the 'UDPX' of rat liver incorporates phosphorus-32 pyrophosphate with the formation of a uridine nucleotide. The latter has been identified as uridine triphosphate by the chromatographic methods described by Munch-Petersen *et al.*[2].

Uridine diphosphoglucose obtained from yeast also undergoes pyrophosphorolysis to uridine triphosphate in the presence of the rat liver nuclear fraction; in this instance, the speed of reaction appears to be greater than in the case of the 'UDPX' of rat liver.

Further investigations are in progress to determine the quantitative aspects of the localization of this pyrophosphorylase in cell fractions.

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[1] Paladini, A. C., and Leloir, L. F., *Biochem. J.*, **51**, 426 (1952).
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VANADIUM AS AN ESSENTIAL ELEMENT FOR GREEN PLANTS

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THE use of the green alga, *Scenedesmus obliquus*, for the study of the micronutrient requirements of green plants has yielded evidence that vanadium is essential. The identification of this new micronutrient for the growth of algae resulted from experiments concerned with their iron nutrition. When *Scenedesmus* was grown in a purified basic nutrient solution supplemented with all the known essential micronutrients for green plants, boron, manganese, copper, zinc and molybdenum (the *A5* solution[1]), a marked increase in growth was observed with increasing iron concentrations. Since the iron salts in these experiments were not purified, it seemed possible that the increase in growth at high iron concentrations resulted from some unknown essential micronutrient commonly present as an impurity in iron salts.

This supposition was tested by growing *Scenedesmus* at three levels of iron supply: 0·1, 1·0 and 4·0 mgm. of iron per litre of nutrient solution. Purified ferric chloride[3] was used as a source of iron. To one series of cultures was added a supplementary solution (*B3*) which provided 10 μgm. per litre each of cobalt, nickel and vanadium, three elements which were likely to have been among those removed by the purification of ferric chloride. The results are shown in Fig. 1. In this, as in all subsequent experiments, growth as measured by dry weight (shown here), and by the additional criteria of fresh weight (packed cell volume), cell count and chlorophyll content, gave concordant results.

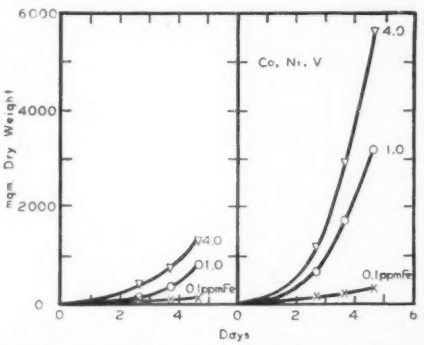

Fig. 1. Effect of a mixture of cobalt, nickel and vanadium (*B3* solution) on the growth of *Scenedesmus obliquus* in a purified medium at three levels of iron: 0·1, 1·0 and 4·0 p.p.m. Left: growth (mgm. dry weight per litre of nutrient solution) without the addition of the *B3* solution. Right: effect of adding the *B3* solution. The *B3* solution supplied 10 μgm. per litre of cobalt, nickel and vanadium as cobalt nitrate, nickel sulphate and ammonium vanadate, respectively

0·1 mgm. iron per litre was clearly insufficient for growth regardless of the addition of the supplementary solution *B3*. However, at 1·0 and 4·0 mgm. iron, a marked increase in growth has resulted from the addition of a mixture of cobalt, nickel and vanadium. At iron concentrations adequate for vigorous growth, that is, 1 mgm. or more per litre, the growth of algae was distinctly limited by the insufficiency of at least one of the three elements in the *B3* solution. Fig. 2 shows that vanadium was the effective element. The addition of cobalt or nickel gave no measurable increase in growth. In another experiment, four parallel cultures were grown in a purified medium without the addition of vanadium. On the fourth day when a deficiency was apparent, the addition of vanadium to two of the cultures was followed by a sharp increase in growth (Fig. 3).

Of sixteen other elements, titanium, chromium, tungsten, aluminium, arsenic, cadmium, strontium, mercury, lead, lithium, rubidium, bromine, iodine, fluorine, selenium and beryllium (the remaining elements in the *B6* and *C13* solutions[2]), added to the vanadium-deficient cultures, none was found

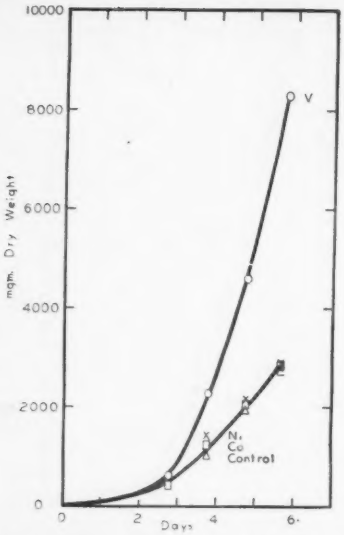

Fig. 2. Effect of nickel, cobalt and vanadium (supplied from sources and in amounts given in legend to Fig. 1) on the growth of *Scenedesmus obliquus* (mgm. dry weight per litre of nutrient solution). 1 p.p.m. iron was supplied as ferric chloride

capable of substituting for vanadium. This specificity[3] of vanadium is regarded as supporting its proposed status as an essential element for green plants. Although we know of no evidence at present for the indispensability of vanadium for other plants, it appears likely that vanadium, like other micronutrients the essentiality of which was at first rigidly established for only one plant species[4], will be shown to be generally required by green plants. Bertrand[5] has already found that vanadium is widely distributed in plants. Of sixty-two species analysed by him all contained this element.

A biological role for vanadium is not confined to green plants. Bertrand[6] has concluded that vanadium is an essential micronutrient for *Aspergillus niger*. The occurrence of a vanadium pigment in Tunicates has long been recognized (cf. ref. 7). It is also of special interest that vanadium can replace molybdenum as a catalyst in nitrogen fixation by *Azotobacter* and *Clostridium*[8], although there is no evidence that vanadium is required in the presence of molybdenum. In our experiments, the requirement for vanadium was observed in the presence of an adequate supply of molybdenum and, conversely, in the investigation of the essentiality of molybdenum for *Scenedesmus*[9] there was no evidence for the replacement of molybdenum by vanadium. Other observations also point to specific effects of vanadium as distinct from molybdenum. The minimum molybdenum requirement of *Scenedesmus* was found to be low: approximately 1,200 atoms of molybdenum to a single cell. There was no improvement in growth at concentrations greater than 0·1 μgm. molybdenum per litre of nutrient solution[9]. With vanadium, increasing initial rates of growth were observed with concentrations up to 100 μgm. vanadium per litre. Under conditions of molybdenum-deficiency *Scenedesmus* showed a marked decline in chlorophyll concentration, whereas with the vanadium-deficient algae the decline in chlorophyll content was much less pronounced.

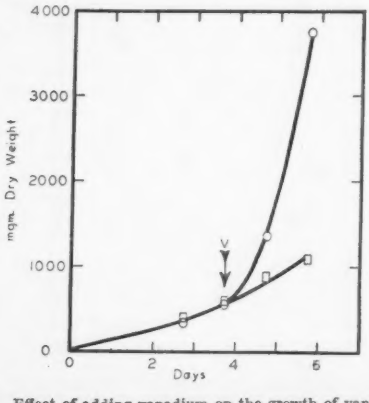

Fig. 3. Effect of adding vanadium on the growth of vanadium-deficient *Scenedesmus obliquus* cultures. At the time indicated by arrow, 20 μgm. vanadium (as ammonium vanadate) was added per litre of nutrient solution. Growth is expressed in milligrams dry weight per litre of nutrient solution. 1 p.p.m. iron was supplied as ferric chloride

The algae were grown in a basic nutrient solution of the following composition: 0·020 *M* potassium nitrate, 0·002 *M* potassium dihydrogen phosphate, 0·001 *M* magnesium sulphate, 0·0005 *M* calcium nitrate, supplemented with the *A*4 solution[1] (boron, manganese, zinc and copper). Molybdenum was added at a concentration of 0·1 μgm. per litre, which was previously found adequate for growth of this organism under the same conditions[9]. Iron was supplied in variable amounts as ferric chloride. The basic nutrient solution salts were individually purified by co-precipitation with copper sulphide[10]. Ferric chloride was separated from other metal impurities by extraction with ethyl ether in hydrochloric acid[2]. 'Pyrex' glass-distilled water was used throughout in making up nutrient media. The initial *p*H of the solution was adjusted to 6·7 with potassium hydroxide.

The algae were grown in 1-litre 'Pyrex' Roux culture bottles containing 240 ml. of nutrient solution inoculated at the rate of 10^8 cells per litre. The bottles were laid flat and shaken continuously in a horizontal plane on a 'pendulum type' shaker[9]. Continuous illumination from below was provided by a bank of fluorescent lights giving an incident light intensity of 1,000 foot-candles. A mixture of air and approximately 5 per cent carbon dioxide was continuously supplied to the nutrient solution. Full details of this investigation will be presented elsewhere.

We wish to thank Drs. Robert Emerson and R. C. Fuller for cultures of *Scenedesmus*, and Dr. C. M. Johnson for a preparation of purified ferric chloride.

[July 28.

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LETTERS TO THE EDITORS

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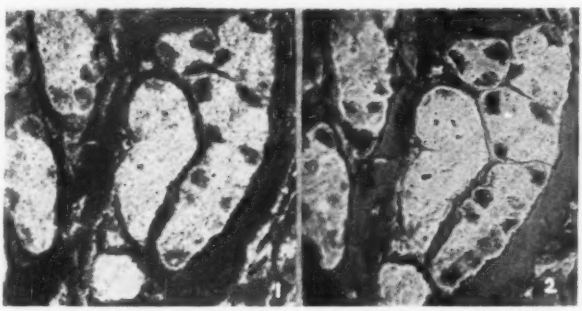
A Comparison between the X-Ray Absorption and Optical Interference Methods for the Mass Determination of Biological Structures

In histo- and cyto-chemistry there has been a trend towards the development of specific techniques for the identification and quantitative determination of biologically important compounds. However, there is a great need for a completely non-specific method which records the total mass of cell structures irrespective of the chemical nature of their constituents. Two such methods have been developed in recent years. One is based on the absorption of very soft X-rays by the biological tissue[1]. As the samples are investigated *in vacuo*, the total dry mass is obtained. The other method[2,3] makes use of measurements of cell refractivity or optical path-length, which is related to the total mass of substances other than water, that is, the dry mass. Measurement of optical path-differences can be made by means of interference microscopy, and the application of the Dyson interference microscope[4] in quantitative cytochemistry has been discussed[5].



Section of dog gastric mucosa. (1) X-ray absorption image; (2) interference contrast

We have compared the results obtained by these two methods when applied to a variety of biological structures. Visual comparison between the images in X-ray and interference contrast (using the Dyson microscope made by Cooke, Troughton and Simms) revealed a similarity in the distribution of the total dry substance. This is illustrated in the comparative photomicrographs (Figs. 1 and 2) of a section of dog gastric mucosa, 3 μ thick. The interference picture (Fig. 2) was taken with an even illumination over the field, and under these conditions it may be shown that the distribution of light intensity can run approximately parallel with the dry mass per unit area. The parietal cells with low mass per unit area and the chief cells with relatively high mass per unit area appear dark and light respectively in both types of contrast. A similar correspondence between the distribution of dry substance was found in all types of tissues examined, for example, muscle fibres, blood cells, nerve cells and nerve fibres. The mass variation in intact bone as revealed by X-rays of shorter wave-lengths was also in agreement with that shown by interferometry.

Table 1

Material		$\mu\mu$gm./μ^2 X-rays	$\mu\mu$gm./μ^2 Interference
Skin (human)			
Str. corneum point	1	2·7	2·5
	2	3·0	2·9
	3	3·2	2·9
	4	3·0	2·9
Str. mucosum	5	1·3	1·4
	6	0·9	1·0
	7	1·0	1·2
Aorta 1 (rabbit)		1·7–1·8	1·3
" 2 "		1·7	1·2
Gastric mucosa (dog)			
Parietal cells		0·8–1·0	0·8–1·3
Chief cells		2·3–2·6	2·2–2·8
Ventral horn cells (dog)	1	1·3	1·1
	2	1·5	1·3
	3	1·6	1·6
	4	1·2	1·3
Thyroid follicles (rat)	1	1·4	1·5
	2	1·4	1·4
	3	1·8	2·0
	4	1·8	1·7
	5	1·6	1·7
	6	1·7	1·9
	7	1·4	1·9
	8	1·5	1·9

Table 1 contains some of the quantitative measurements made on a variety of materials using the two techniques, and it shows that there is a fairly good agreement. The above results were obtained with structures of varying degrees of inhomogeneity. On homogeneous retinal rods from the frog, the concentrations of dry substance obtained by X-rays and interferometry were 0·41 and 0·39 $\mu\mu$gm./μ^2 respectively.

The relative features of the two methods may be summarized as follows. The structural resolving power of the present X-ray method is about 1 μ, whereas the interferometric technique has the full resolving power of the light microscope. A difference in mass per unit area of about 0·1 $\mu\mu$gm./μ^2 can just be detected by the X-ray technique, whereas the sensitivity of the interferometric method may well be an order of magnitude greater.

However, the particular advantage of the interference microscope is that it may be used for following the changes in dry mass of individual living and undamaged cells. In the X-ray method, fixation artefacts are minimized by the use of freeze-drying. It is difficult to state precisely the accuracy of the quantitative measurements obtained by each of the two methods, as it depends on technical procedure and the nature of the biological material. A full account of this work will be published elsewhere.

Participation in this work in Stockholm was made possible for one of us (H. G. D.) by a grant from the Swedish Anti-Cancer Society.

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A New Method for the Quantitative Determination of Chloride in Plant Material

Using the well-known property of a silver – silver chloride electrode of behaving both as a silver electrode and a chlorine electrode, it appeared possible to develop a new quantitative determination of chloride in aqueous solutions.

Two silver electrodes, coated electrolytically with silver chloride, dip into a solution containing chloride which is titrated with silver nitrate. A small potential difference (about 100 mV. direct current) is set up between the electrodes, the current flowing being measured with a sensitive galvanometer (Fig. 1).

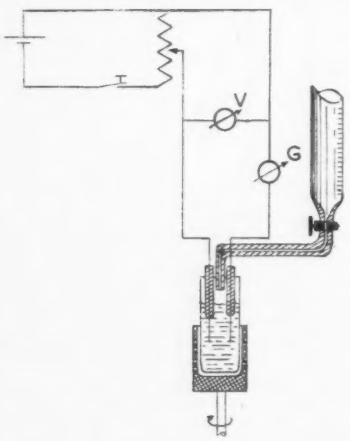

Fig. 1

So long as the chloride concentration is greater than the square root of the solubility product of silver chloride, a current flows, accompanied by the reactions:

Cathode	Anode
$AgCl + e \rightarrow Ag + Cl'$	$Ag + Cl' \rightarrow AgCl + e$

This current is limited by the chloride concentration, so it decreases during titration until it reaches a minimum value at the end point, where $[Ag\cdot] = [Cl'] = \sqrt{L_{AgCl}}$ (L = solubility product).

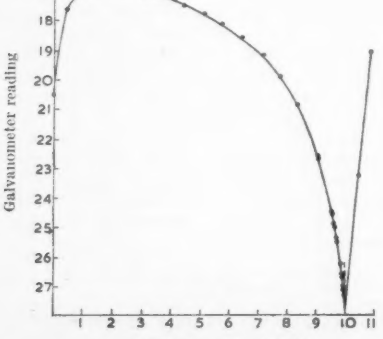

Fig. 2. Titration of 0·5 m.eq. of sodium chloride; electrolysis potential, 100 mV.

The first excess silver ions cause another current, this time governed by the reactions:

Cathode	Anode
$Ag\cdot + e \rightarrow Ag$	$Ag \rightarrow Ag\cdot + e$

Hence the equivalence point is indicated very sharply by the galvanometer (Fig. 2). The end point can be established without any graphical work.

This method is quicker and safer than a potentiometric determination of chloride[1] in consequence of its independence of any reference half-cell and the direct determination of the end point. Stirring of the solution is necessary; in order to be able to titrate in a small volume, we used a simple rotating titration vessel.

This titration makes possible a quick determination of the chloride content of plant material without destruction or filtration. Best (*l.c.*) showed that ashed samples give lower results, perhaps caused by a loss of chloride in the ashing process. We boiled the dried and ground sample with distilled water for half an hour, and titrated it in the same vessel without filtration. The following results indicate that in this way even better results may be obtained than after filtration of the plant sample.

Quantity of dried grass (gm.)	Treatment	Chloride content of the grass (per cent)	
1	Boiled, filtered, titrated in 50 ml.	0·91	0·92
1½	Boiled, filtered, titrated in 50 ml.	0·85	0·85
2	Boiled, filtered, titrated in 50 ml. After filtration, the grass was washed six times	0·76	0·77
½	Boiled, titrated in 50 ml. without filtration	0·94	0·94
1½	Boiled, titrated in 50 ml. without filtration	0·92	0·94

As the electrode system is reversible, the same electrochemical principle can be used for determining the silver ion concentration of any aqueous solution. This method is an application of the principle of the dead-stop end point titration (as described by Stone and Scholten[2]), using second-order electrodes as oxidation-reduction electrodes.

A detailed report on this electrometric titration technique and its applications in plant analysis will be published elsewhere.

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Adrenaline, Noradrenaline and Hydroxytyramine in Extracts from Insects

Evidence that the specific ergone of the adrenergic system in mammals is noradrenaline has been given by Euler[1]. So far, noradrenaline does not seem to have been demonstrated in extracts from insects.

As material in the present study, larvæ and adult insects of *Tenebrio molitor*, and larvæ, pupæ and

Table 1

Species	Tissue	Methods of extraction	Noradrenaline (μgm./gm. body-weight)	Adrenaline (μgm./gm. body-weight)	Hydroxytyramine (μgm./gm. body-weight, approximate)	Adrenaline as percentage of adrenaline and noradrenaline
Tenebrio molitor, adults	Whole body	Trichloracetic acid	1·14	0·151	10–15	12
,, ,, larvæ	,, ,,	,, ,,	2·20	0·061	10–15	3
Apis mellifica, adults	,, ,,	,, ,,	0·75	0·050	5–10	6
,, ,, pupæ	,, ,,	,, ,,	0·22	0·026	2–4	11
,, ,, larvæ	,, ,,	,, ,,	0·30	0·005	2–4	2

adult insects of *Apis mellifica* were used. The insects were carefully freed from foreign material and weighed. After grinding in a mortar together with chemically pure sand, the tissue was extracted with three volumes of 6 per cent trichloracetic acid. The sympathomimetic catechol amines were adsorbed with the aid of aluminium hydroxide[2]. After evaporation *in vacuo* to suitable volume, the amounts of adrenaline and noradrenaline were determined by comparative tests on the cat's blood pressure and the hen's rectal cæcum[3]. The approximate amounts of hydroxytyramine were estimated by paper partition chromatography against known standard solutions of adrenaline, noradrenaline and hydroxytyramine after development with potassium ferricyanide[4] (Table 1).

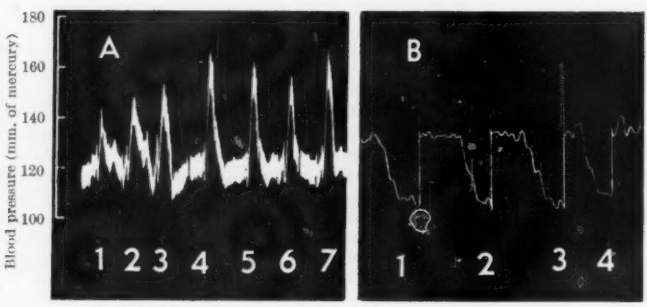

Fig. 1. (*A*) Cat's blood pressure. (1) 0·1 μgm. noradrenaline. (2) 0·4 μgm. adrenaline. (3) 0·15 μgm. noradrenaline. (4) 200 mgm. of *Tenebrio molitor* (adults). (5) 80 mgm. of *Tenebrio molitor* (larvæ). (5) 165 mgm. of *Tenebrio molitor* (adults). (7) 0·2 μgm. noradrenaline. Ordinate: Blood pressure, 100–180 mm. mercury. (*B*) Hen's rectal cæcum. (1) 64 mgm. of *Tenebrio molitor* (larvæ). (2) 0·3 μgm. noradrenaline. (3) 50 mgm. of *Tenebrio molitor* (adults). (4) 0·006 μgm. adrenaline

In purified extracts from *Tenebrio molitor* and *Apis mellifica*, three biologically active substances were demonstrated which by biological assay and paper chromatography were identified as adrenaline, noradrenaline and hydroxytyramine (see recordings reproduced herewith and Table 1). In extracts from other kinds of insects results in agreement with the above have been found. A full account of this work will be published in *Acta Physiol. Scand.*

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Carbon Dioxide Fixation and Mitotic Poisons

VARIOUS categories of compounds have been classified as 'mitotic poisons' in the belief that the action mimicked that of a standard compound, such as colchicine. In some cases, such as the halogenated benzenes, it was known that these substances were not completely equivalent since, for example, they did not produce polyploidy[1]. The mechanism suggested whereby some substances were effective as poisons was interference with protein sulphydryl groups in particular and with carbohydrate metabolism in general[2]. It was of interest to test this hypothesis by determination of the extent of inhibition of reversible carbon dioxide fixation.

Six to eight excised onion or soybean roots, *c.* 1 cm. in length, were divided into two equal groups, one placed in the poison solution, the other in tap water. (In separate experiments, root-tip and elongation regions showed no profound differences.) Time and concentration conditions (3 hr., $2{\cdot}7 \times 10^{-3}$ *M* for colchicine; a saturated aqueous solution for the others, except where indicated) were such as to give the usual mitotic aberrations with the normal staining procedure. Following treatment, the roots were transferred to 1 ml. distilled water in a screw-cap vial. Equal aliquots of sodium bicarbonate (carbon-14) were added to treated and control vials, and the screw-caps replaced and tightened. After one hour contact time, the roots were dropped into boiling 80 per cent ethanol, in which the metabolic acids are extracted within no more than twenty minutes gentle refluxing. The extracts were then quantitatively transferred to small glass cones, air-concentrated there by a blower to *c.* 0·1 ml. and then transferred quantitatively to Whatman No. 1 sheets for subsequent chromatography. The amount of fixation was determined at this point by counting the original spot on filter paper directly with an end-window counter. The pattern of carbon dioxide fixation, details of which will be the subject of another communication, was always identical, regardless of the degree of inhibition. Inhibition therefore does not occur within the tricarboxylic cycle itself. Furthermore, soybean and onion roots displayed identical radiograms.

Bromobenzene is a typical substance which has been classed as a mitotic poison. Its time course of respiratory inhibition is given in Fig. 1. The undulatory nature of the initial aspects of the control may result from the excision immediately preceding the 10-min. equilibration. The inhibition is just as readily removed (cf. Table 1), and consequently standard

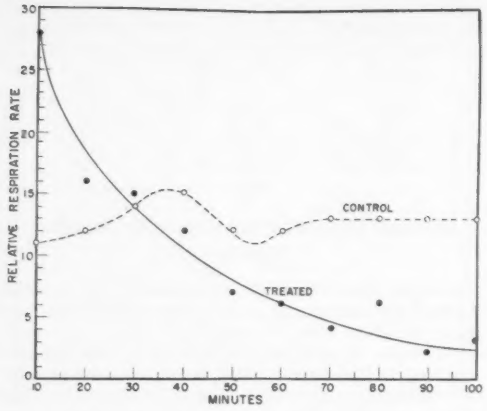

Fig. 1

practice consisted in the immediate transfer of roots from poison to bicarbonate solution. (Different levels of initial activity were used in different experiments, although control and treated were given identical aliquots. Consequently, absolute counts of different experiments cannot be compared, although ratios can. In the counting system used, where the geometry is *c.* 5 per cent, counts were of the order of 10^4/min. The infinite ratio indicates merely that treated samples were background within the statistical error used (± 5 per cent standard deviation). We do not infer that absolutely no activity is present.)

Table 1. Rate of Recovery of Roots from Treatment with Bromobenzene

Exp. No.	Equilibration time* (min.)	Ratio of activity control/treated
1*a*†	0	∞
1*b*†	0	∞
2	20	∞
3	30	3·0
4	40	2·2
5	50	1·3

* Time between removal of treated roots from bromobenzene and equilibration in distilled water prior to the addition of sodium bicarbonate (oxygen-14).
† Five-day old soybean roots; other experiments, onion.

Table 2. Effect of Various Compounds on Carbon Dioxide Fixation by Onion Roots

Compound	Ratio of activity in control/treated
(1) Colchicine *a*	1·0
b	1·1
*c**	1·2
(2) Podophyllin	1·0
(3) Acenaphthene	1·1
(4) 2,4,6-Trichlorophenoxyacetic acid†	
a, 10^{-3} *M*	∞
b, 10^{-4} *M*	1·0
c, 10^{-5} *M*	1·1
d, 10^{-6} *M*	∞
e, 10^{-6} *M*	0·94
f, 10^{-7} *M*	0·38‡

* 1 hr. 'equilibration time'; cf. Table 1.
† By courtesy of Dr. R. Weintraub, Chemical Division, Camp Detrick, Frederick, Md.
‡ This apparently indicates stimulation.

The experiments indicate that bromobenzene may act as a potent respiratory poison as do various other halogenated aromatic compounds. However, as is shown in Table 2, mitotic poisons such as colchicine and acenaphthene which act in very low concentrations (for example, *c.* 10^{-7} *M* and 10^{-6} *M*, respectively) and are able to exert an effect on respiration only at a much higher concentration (*c.* 10^{-3} *M*)[3] show no effect on reversible carbon dioxide fixation at the lower level. It is therefore quite possible that the halogenated aromatics, or any substance which inhibits a normal glycolytic pathway, will thereby affect mitosis indirectly. It does not appear proper, however, to classify such substances as mitotic poisons.

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Effect of 2,2-*bis*(Parachlorophenyl)-1,1-Dichloroethane (DDD) on the Adrenal Cortex of the Rat

While DDD has been repeatedly shown to produce selective degeneration of the zona fasciculata of the adrenal cortex in the dog[1] when fed in daily doses of 50 mgm./kgm., no such effect has been found in rats receiving as much as 2,500 p.p.m. of the drug in the diet[2]. Physiological changes have been described in rats fed 1,000 p.p.m. DDD which have been attributed to adrenal cortical dysfunction[3], and histological damage has been reported after the injection of about 5 gm. over a period of 4–6 weeks[4]. Since a rat without zona fasciculata but with intact zona glomerulosa, adrenal medulla and pituitary would be of great help in the elucidation of certain problems of adrenal cortical function, attempts were made to produce degeneration of the zona fasciculata by injecting DDD in arachis oil. These attempts were unsuccessful, in agreement with the findings of Dr. I. C. Jones (personal communication) in both rats and mice, and so the regeneration of the adrenal cortex after medullectomy was observed in rats treated with DDD, since it was thought that this might be a sensitive test for a cytotoxic effect on the adrenal cortex.

Two groups of ten male rats (Porton strain), fed on M.R.C. Diet 41, were used, one group being given 20 mgm. DDD/100 gm. body-weight as a 4 per cent solution in arachis oil subcutaneously three times a week, the other group receiving an equivalent amount of arachis oil. DDD was obtained by recrystallization from a commercial sample of 'Rothane' (Rohm and Haas, kindly given by Charles Lennig and Co.). After the third dose, all the rats were medullectomized under ether by the method of Evans, as quoted by Ingle and Griffiths[5]. Treatment with either DDD or arachis oil alone was continued, and in addition the rats were given 1 per cent sodium chloride to drink for the first week after operation. Five rats in each group were killed at 14 days and the remainder at 28 days after the operation. The adrenals were weighed and examined histologically (hæmatoxylin and eosin: sudanophilia; birefringence after treatment with digitonin).

Before and after medullectomy, the DDD-treated rats appeared normal and grew at the same rate as the controls. The adrenal weights (mgm./100 gm. body-weight) of the treated group did not differ significantly from the controls either at 14 days

(treated 10·0 ± 1·9, standard deviation); controls 9·8 ± 2·0) or 28 days (treated 10·7 ± 1·6; controls 10·9 ± 2·0). Histologically, the medulla was absent in all cases and the appearance of the cortex in paraffin sections (hæmatoxylin and eosin) was the same in the two groups. The distribution of sudanophilic lipid and birefringent crystals after treatment with digitonin was also the same in the two groups, both from the points of view of amount and of size of the droplets or crystals.

Under these experimental conditions, DDD did not interfere with the regeneration of the adrenal cortex after medullectomy, suggesting that it does not exert any striking cytotoxic effect on the rat adrenal cortex. The effect of this compound in the dog may be due to a greater susceptibility of the adrenal cortex to toxic agents in that species, in which spontaneous adrenal cortical atrophy can occur[6].

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The Epineurium as a Diffusion Barrier

According to Lorente de Nó[1], it is "utterly impossible to believe that the connective tissue sheath of frog or bullfrog nerve could act as a diffusion barrier that would delay for considerable periods of time the penetration of solutes into the nerve". This statement, reaffirmed in subsequent publications[2–4], is diametrically opposed to the results of other authors who believe that both 'desheathed' nerves and individual nerve fibres react to a variety of substances much more rapidly than do intact nerves[5–11]. Lorente de Nó[2], on the other hand, points out that neither the perimysium[12], which resembles a nerve sheath in structure, nor the connective tissue sheath of the squid axon[13] functions as a diffusion barrier. He therefore refuses to allow a similar claim in the case of the frog's sciatic nerve, the sheath of which is no denser than the structures just mentioned. As further evidence, Lorente de Nó points out that the post-ganglionic trunk of the cat's superior cervical ganglion in microscopic section is claimed to show continuity between collagen fibres of epineurium and endoneurium.

Time of Appearance, after Treatment with 0·5 per cent Silver Nitrate, of Endothelial Cell Borders and Nodes of Ranvier in the Peripheral and Central Fibres of the Peroneal Trunk of the Frog.

Each Point in this Table Represents at Least Five Measurements

	Endothelium cell borders (min.)	Nodes of Ranvier in outer fibre layers of peroneal nerve (min.)	Nodes of Ranvier in central fibre layers of peroneal nerve (min.)
Intact nerve	3	70–90	80 and more
Intact nerve treated with chloroform	–	3	10
'Desheathed nerve'	–	3	5

Since, however, the experimental evidence involves somatic nerve bundles such as the peroneal, tibial and sciatic nerves of frogs and bullfrogs, it would seem more useful to study the microscopic anatomy of these nerves. Work on these lines has shown that the epineural sheath of these nerves—and also of similar nerves in mammals—does not merely consist of more or less dense connective tissue. Key and Retzius[14] and Ranvier[15] found, as was pointed out recently by Huxley and Stämpfli[8], a lamellar structure which surrounds the nerve trunk. This structure consists of two endothelial lamellæ lying on top of each other, enclosing a fine gap which, according to Key and Retzius[14], communicates with the subarachnoid space of the central nervous system. This gap shows no structural elements connecting the epineurium with the endoneurium. Even in preparations of the entire nerve, the limits of the endothelial cells can be readily shown by the use of silver nitrate (Fig. 1). By impregnation with lead-nitrate and subsequent treatment with yellow ammonium sulphide, the nuclei and borders of the endothelium-like cells can be made visible (Fig. 2). If the tissue is stained after the usual fixation and embedding, the structure can still be clearly distinguished from connective tissue, although cell borders are not seen (Fig. 3). Neither the perimysium nor the sheath of squid axon have any such structure; Lorente de Nó's comparison therefore does not hold.

Treatment of myelinated nerve with silver nitrate before fixation is commonly used for making the nodes of Ranvier visible. Their time of appearance in an intact and in a 'desheathed' peroneal trunk of the frog (*R. temporaria*) is shown in the accompanying table. In both, nodes of Ranvier can already be seen after exposure to 0·5 per cent silver nitrate for 3 min., provided that the intact nerve trunk was treated

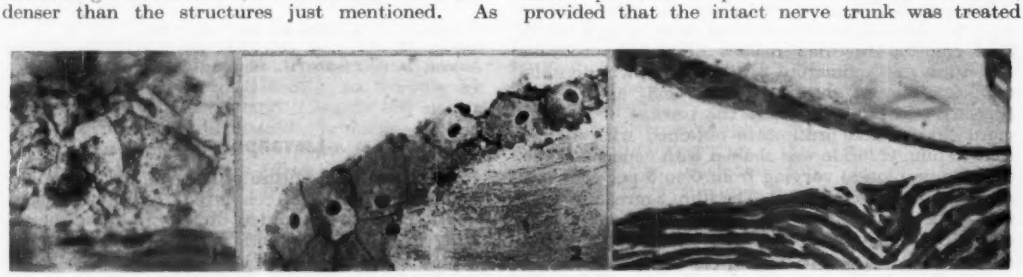

Fig. 1. Sciatic nerve, frog. Borders of endothelium cells, stained for 5 min. with 0·5 per cent silver nitrate. × 110

Fig. 2. Sciatic nerve, dog. Limits and nuclei of the epineural endothelium. Lead nitrate 5 per cent, buffered with acetate at *p*H 4·9, 8 days at 37° C. Visualization by yellow ammonium sulphide. Frozen section. × 170

Fig. 3. Sciatic nerve, rabbit. The endothelium has been lifted from the underlying nerve trunk by an artefact. Nuclei and cytoplasm are visible, although cell borders are not seen. Nerve stained with Bodian's silver method after paraffin embedding. × 350

with chloroform beforehand. In intact nerve, however, stained with the same solution without prior treatment with chloroform, only the cell borders of the endothelial barrier can be seen after the same interval. In these circumstances, between 70 and 90 min. must elapse before the endothelial barrier is passed, and nodes of Ranvier begin to show.

It is concluded, therefore, that somatic nerves of frogs, dogs, rabbits and cats are surrounded by an endothelium-like double membrane. Its endothelial layers constitute a definite barrier to the diffusion of silver nitrate.

I wish to thank Prof. A. von Muralt, of Berne, for giving me facilities for this investigation and for his continued interest and advice, Prof. J. M. Yoffey, of Bristol, for assisting with the translation of this communication into English, and the Deutsche Forschungsgemeinschaft for financial support.

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A Soluble Form of Reconstituted Collagen

In attempting to repeat some experiments reported by von Buzagh[1], it was noticed that the fibrous precipitate (Fig. 1), formed by adding a 10 per cent sodium chloride solution to a solution of calf Achilles tendon in 1·2 per cent acetic acid, dissolved in 0·9 per cent sodium chloride; on dialysis of this solution, a fibrous precipitate was re-formed. In contradistinction, the precipitates obtained from solutions of tendon in acetic acid at concentrations more generally used (0·01–0·4 per cent)[2] are insoluble in 0·9 per cent sodium chloride. The physical properties of reconstituted collagen thus vary according to the concentration of the acetic acid used for dissolving the original tendon.

Solution in 0·9 per cent sodium chloride occurred rapidly; but examination of the material just before final solution revealed masses of tapered rod-like structures approximately 2–5 μ in length, individual rods sometimes showing end-to-end aggregation (Fig. 2). In order to study the process of solution more closely, the precipitate obtained with 10 per cent sodium chloride was shaken with concentrations of sodium chloride varying from 0 to 5 per cent and examined microscopically. The fibre aggregates were first split longitudinally, so that in 2 per cent sodium chloride the precipitate consisted mainly of long fine filaments. Below this concentration the filaments appeared to be broken transversely into short rod-like structures.

In another experiment, sodium chloride to a final concentration of 1–5 per cent was added to aliquots

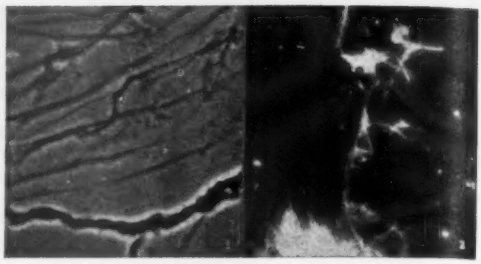

Fig. 1. Fibres obtained by 10 per cent sodium chloride from a solution of tendon in 1·2 per cent acetic acid. Phase-contrast microscopy. (× 350)

Fig. 2. Tapered rods formed during solution of reconstituted collagen in 0·9 per cent sodium chloride. Dark ground illumination. (× 400)

of a solution of tendon in 1·2 per cent acetic acid. With 1 per cent sodium chloride no precipitate was formed. With 1·5 per cent the precipitate was granular; at 2 per cent the precipitate contained granular material, long fine filaments and the rod-like structures; at 2·5 per cent and higher the precipitate was wholly fibrous.

It seems likely that these different forms represent intermediate stages in the building up of the fibre aggregates, the granular material forming rod-like structures which link end to end to form long fine filaments, and that these in turn aggregate at right angles to their long axis to form the thicker fibres. The linkages must be weak since the fibres are easily broken up by 0·9 per cent sodium chloride solutions, first into filaments, then into rods, and finally going into solution. However, when chondroitin sulphate is used as the precipitating agent, the resulting fibres are insoluble in 0·9 per cent sodium chloride. If these fibres are incubated with hyaluronidase, which is known to break down chondroitin sulphate, they become soluble in 0·9 per cent sodium chloride with the intermediate formation of the rod-like structures. This suggests that chondroitin sulphate strengthens both the transverse and end-to-end linkages in this type of reconstituted collagen, and strengthens the evidence previously presented[3] that chondroitin sulphuric acid is concerned in stabilizing the structure of tendon.

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Lævanpolyase

Sucrose in the culture of a lævan-forming micro-organism might be converted into invert-sugar directly by invertase, or less directly by lævansucrase[1] acting in conjunction with a lævan hydrolase[2]. An enzyme which does not cleave sucrose either hydrolytically or polymeratively and which hydrolyses a high polymer lævan has been designated 'lævanpolyase', and has been separated by us from the culture fluids of two lævan-formers (*Azotobacter*

chroococcum and *Bacillus asterosporus*) growing on lævan. The study of this enzyme has helped define the role of lævan as an intermediary of the process whereby lævan-forming micro-organisms may utilize sucrose totally.

Lævanpolyase was freed from lævans and reducing sugars and obtained as a water-soluble transparent gel by precipitation with ammonium sulphate (50 per cent saturation) from the extracellular fluid of a young culture of *Azotobacter chroococcum* growing in a thin fluid layer on agar containing lævan of *Aerobacter levanicum* as sole source of carbon. The enzyme produced loss of turbidity in lævan solutions and an attendant restricted hydrolytic cleavage of the polymer. At the end of the reaction, the reducing power corresponded to approximately 18 per cent total hydrolysis.

The lævan digest was fractionated with alcohol and the recovered fractions were exposed to the further action of fresh enzyme. With this procedure the mixture of the true limit lævans was afforded. The latter were resolved by alcohol fractionation and paper chromatography, and the resolved components were characterized on the basis of reducing power, precipitability by alcohol, lability to invertase, and velocity of migration in paper. Reference oligolævans were prepared from lævan by partial acid hydrolysis. The distribution of weight of the homologues in the reaction mixture of the exhaustive degradation of the lævan by lævanpolyase was: fructose, 0; lævanbiose, 0; lævantriose plus lævantetraose, approximately, 20; higher members of lævan homologue series (average polymerization degree = 11), approximately 80.

The important features are: (*a*) that lævan is converted by lævanpolyase not into a single limit product but into a mixture; and (*b*) that this mixture contains neither fructose nor lævanbiose. Consistent with these features is the assumption that the *Aerobacter* lævan molecule, at sites at least three fructose units distant from the chain terminals, contains anomalous or branch linkages[3], and that lævanpolyase hydrolyses these specifically. On the other hand, if the *Aerobacter* lævan molecule is a linear chain free from anomalous linkages, lævanpolyase would have to be regarded as a selective endotype enzyme which only cleaves the typical lævan interfructosidic linkage if it is in a chain of sufficient length and at a locus sufficiently distant (3 or more fructose units) from the chain terminals. A structural study of the *Aerobacter* lævan to decide between these alternatives is under way.

The lævanpolyase preparation hydrolysed inulin only very slowly; it failed completely to cleave sucrose either hydrolytically or polymeratively. It failed to split lævantriose and related low oligolævans. These (lævantriose, lævantetraose) were, however, readily hydrolysed totally to fructose by yeast invertase, which is inert towards the native lævan. Lævanpolyase is therefore probably distinct from hitherto recognized fructosidase entities.

When this *Azotobacter* was grown on sucrose rather than on lævan as source of carbon, the extracellular fluid of the culture hydrolysed lævan to well beyond the limit which was characteristic of the lævanpolyase reaction. Chromatographic analysis of the digest at different stages of reaction revealed consistently in this case the presence of fructose, lævans of relatively high molecular weight, and little or no lævanbiose, lævantriose or lævantetraose. Unlike the preparation of enzyme from the lævan-grown cells, that from the sucrose-grown cells hydrolysed sucrose.

On the basis of these findings, a scheme of the metabolism of sucrose via lævan by cultures of lævan-formers has been formulated. The scheme postulates a sequence of three, essentially irreversible, repetitive reaction steps:

(1) Sucrose $\xrightarrow{\text{lævansucrase}}$ lævan + glucose;

(2) Lævan + water $\xrightarrow{\text{lævanpolyase}}$ limit oligolævans;

(3) Limit oligolævans + water $\xrightarrow{\text{lævanoligase or sucrase}}$ fructose.

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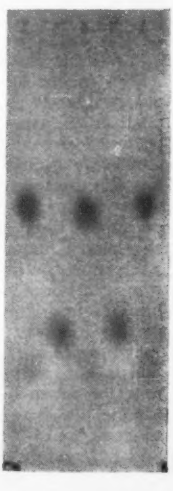
Association of Xylan with α-Cellulose in Jute

Das *et al.*[1] have recently reported (without reproducing any photograph) the presence of xylose (and also arabinose) in the α-cellulose from jute, in contradiction to our finding[2]. Formic acid, used instead of sulphuric acid for hydrolysis, is stated to have achieved the result. To check this, we have repeated both the procedures; experimental facts do not, however, indicate the superiority of formic acid. Purified α-cellulose ('furfural' content 0·7 per cent) from jute, hydrolysed with 85 per cent formic acid at 135° for 12 min., as was done by Das *et al.*, was used for obtaining the photograph reproduced; the original spots (in triplicate), marked with *X*, represent the hydrolysate and *Xyl* (in duplicate) stands for pure xylose. Neither xylose nor arabinose could be detected. Whatman No. 1 filter paper strip, 57 cm. long, was employed, *n*-butanol, acetic acid and water being the solvent; the sugars were fixed with aniline hydrogen phthalate.



α-Cellulose, hydrolysed with formic acid, gives a faint but distinct spot below that for xylose. This was also observed when pure glucose (Baker's Analysed) or α-cellulose from purified cotton was treated with formic acid as stated above, but not with sulphuric acid. If in paper chromatography the solvent is not 'overrun', this spot might be mistaken for xylose. The α-cellulose from jute must be carefully purified, if necessary by repeated treatment with caustic soda solution (10–5 per cent), so as to reduce its furfural content to less than 1·0 per cent, otherwise traces of xylose may appear in the hydrolysate and

so in the paper chromatogram. When pure xylose ('Difco') was treated with formic acid, as mentioned above, and also with sulphuric acid, as stated in our earlier communication, 83·5 and 87·8 per cent respectively could be recovered. Xylose, therefore, is not more resistant to formic acid than to sulphuric acid under the conditions of experiment.

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'Lipase' in Gland Duct Epithelium and in Mucus-secreting Cells

The presence of 'lipase' in the acini of the pancreas and in the cells of the liver is well known, and these two tissues have provided the main material for chemical and histochemical studies of this enzyme. Less attention has been paid to the distribution of this enzyme in other parts of the alimentary tract, though Gomori[1] has described a number of observations. A systematic investigation of this tract, undertaken by means of Gomori's 'Tween' technique[2] (employing 'Tween 40') with some modification[3], has brought out some facts of interest which warrant a brief recording. It is realized that although the term 'lipase' is used here, the histochemical reaction given by the 'Tween' technique probably demonstrates an esterase in most sites rather than true lipase[4].

The alimentary tract of the following species has been studied: dog, cat, rabbit, guinea pig, mouse and rat; and of the variety of observations, the following seem particularly worthy of note.

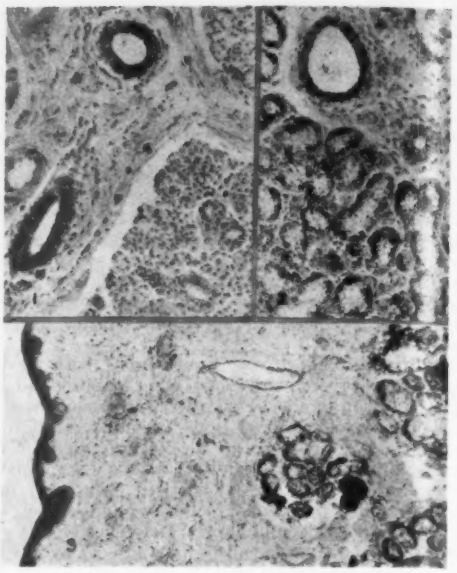
It was found, rather surprisingly, that the epithelium lining the ducts of certain glands commonly showed quite a strong reaction for 'lipase'. This was the case with the ducts of the salivary glands of all the species investigated except the rat (Figs. 1 and 2). The reaction was given particularly by the larger interlobular ducts rather than by the small intralobular ducts, though in some cases both segments of the ducts were found positive. The contents, however, of these ducts were invariably negative.

The mucus-secreting cells lining the ducts of the gastric glands, both of the fundus and pylorus, were positive in some species (dog, cat and rabbit), the pylorus giving the weaker reaction; but in the mouse and guinea pig, the reaction was feeble throughout the ducts of the gastric glands.

In the pancreas, the larger ducts were positive, and here their contents also, which conforms with the active lipase secretion of this organ.

Even in the liver of all the species examined, there was sometimes a slight reaction in the interlobular bile ducts; and the gall bladder showed a weak patchy reaction in the lining epithelium, but not in its contents.

Another striking feature was a positive 'lipase' reaction given by mucus-secreting cells. In salivary glands, for example, it was more often the case that mucous acini reacted rather than serous (Figs. 1 and 2), though 'special' serous acini such as those of the submaxillary gland of the guinea pig reacted strongly, as was first shown by Gomori[1]. Again, the mucus-secreting acini of the œsophageal glands of the dog gave a particularly strong reaction (Fig. 3). Incidentally, their ducts were negative. The reaction of the mucus-secreting cells lining the ducts of stomach glands has already been referred to. The cells of the actual fundic glands were negative in dog, cat and rabbit; but in the guinea pig and mouse, the chief cells often gave a strong reaction.



(1) Parotid gland of dog. × 100. 'Lipase' reaction in epithelium of large interlobular ducts, but not of intralobular ducts. Serous acini negative.
(2) Submaxillary gland of dog. × 100. 'Lipase' reaction in epithelium of large interlobular ducts. Strong reaction in mucous acini, especially at the bases of the cells.
(3) Œsophagus of dog. × 45. Strong reaction for 'lipase' in the mucous acini of the œsophageal glands, especially at the bases of the cells. Gland ducts are negative. Surface epithelium strongly positive as in other species.
All specimens were lightly counterstained for nuclei with hæmatoxylin

The mucous cells of Brunner's glands were always negative. But, in the peculiar case of the rabbit, the serous cells, which are present among the mucous acini of Brunner's glands, were positive (see also Gomori[1]). These cells are believed to represent pancreatic tissue, and thus their positive reaction for 'lipase' may add a point in favour of this view.

Goblet cells of both the small and large intestine appeared to be negative in the species studied.

From the results, certain points particularly stand out. First, gland ducts are probably not so inert physiologically as is commonly supposed, even the larger 'collecting' ducts displaying a reaction for 'lipase'. This seems to suggest a very specific activity of these cells, which may be concerned, if only indirectly, with the final composition of the secretion of the gland. However, it would be rash to conclude that the presence of the enzyme in duct epithelium, or for that matter in glandular cells themselves, does of necessity indicate that the enzyme itself forms part of the gland's secretion. In fact, if one may judge from the lack of histochemical reaction in the duct contents of some of these glands (for example, salivary

glands, liver, dog œsophageal glands), it seems unlikely that this is the case. Secondly, the unexpected reaction in mucus-secreting cells at some sites and absence of such a reaction in cells of this type at other sites draw a new distinction between cells of this class.

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Reflex Stimulation of the Neurohypophysis (Posterior Pituitary Gland) and the Nature of Posterior Pituitary Hormone(s)

THE sensory stimulus of suckling evokes nervous reflex release of the oxytocic substance from the neurohypophysis, which in turn stimulates the contractile tissue of the breast and causes a rise of milk pressure in the mammary ducts[1]. Electrical stimulation of the nerve supply (the supraopticohypophysial tract) of the neurohypophysis, or injection of posterior pituitary extracts (especially the oxytocic fraction)[2], elicits similar effects on the breast. Rise in intramammary duct pressure produced by injection of the oxytocic substance, or by excitation of the milk ejection reflex alone, does not usually result in free flow of milk to the exterior, possibly because of some sphincter-like mechanism at the nipple. In some cases, however, excitation of the milk ejection reflex results in dribbling of milk from a nipple that is not being suckled or milked; for example, the flow that may occur from the unsuckled breast of a nursing woman or from the udder of a cow subjected to routine procedures preceding milking.

In 1947 it was suggested[3] that coitus results in a nervous reflex release of oxytocic substance from the neurohypophysis and thereby an increase in uterine activity and increased speed of transport of seminal fluid up the female reproductive tract. It is therefore of interest that milk ejection has been observed to occur during coitus in one lactating woman[4]; and further information has now been collected from the wives of scientific colleagues. Of twenty-two questioned, thirteen had coitus during the period of lactation, and of these, six noticed that a discharge of milk accompanied some phase of the act of coitus. Complete orgasm does not seem to be essential for the mammary response, since two of the women who observed milk discharge had only incomplete excitation and a third reported that milk ejection preceded the orgasm. Seven women did not observe discharge of milk during coitus; but of these, two noticed a tingling sensation in the breasts which they stated was identical with the sensation accompanying milk ejection evoked by suckling. It seems clear, therefore, that discharge of milk may be excited by the act of coitus, and since there is good experimental evidence that milk ejection is dependent on discharge of the oxytocic substance from the neurohypophysis, it is reasonable to conclude that the sensory stimuli associated with mating cause nervous reflex release of the oxytocic substance. This conclusion is supported by the finding that coitus in the cow results in increased uterine motility[5], which is interpreted as being due to the release of the oxytocic substance.

The problem of how many hormone(s) the neurohypophysis secretes has never been clearly answered. Until a method is developed for assaying the oxytocic substance in venous blood, the most reliable approach would seem to be the measurement of various activities attributable to posterior pituitary activation (inhibition of a water diuresis, milk ejection and uterine contractions) which are excited by different 'physiological' stimuli. Stimuli which might be expected (on teleological grounds) to result in either an antidiuretic effect or an oxytocic effect do, in fact, result in both effects. Thus (1) an increase in the osmotic pressure of carotid blood results not only in an inhibition of water diuresis[6] but also in milk ejection[7] and increased uterine motility[8]; (2) suckling results not only in milk ejection[1] but also in an antidiuresis[9]; (3) coitus results not only in milk ejection (see above) and increased uterine motility[5], but also in an antidiuresis[10].

At the moment, this evidence suggests that the neurohypophysis secretes one hormone with multiple activities. If this is so, it is likely that the substance liberated from the gland has a higher proportion of oxytocic to antidiuretic activity than have standard whole posterior pituitary extracts[3,6,11].

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Proprioceptive Fibres in the Ocular Muscles of the Pig

THE sensory innervation of the ocular muscles differs from that of skeletal muscle generally, both in the calibre of its fibres and in the nature of their endings. Studying the pattern in human, cat and rabbit material, Woollard[1] found that, whereas motor end-plates conform to the orthodox structure, the sensory element of the extra-ocular muscles consists of a system of fine lightly myelinated fibres, terminating—usually on relatively small muscle fibres—in claw-like endings which may be either free or ensheathed, simple or complex.

The origin of the sensory component of the IIIrd and IVth nerves was investigated by Tarkhan[2], who found in cats an intimate connexion between the

fibres of the mesencephalic Vth root and those of the spino-tectal and oculomotor nerve bundles. He also traced a varying number of mesencephalic Vth fibres directly into the trochlear nerve at the level of its decussation.

The early myelination of the mesencephalic Vth root in the pig facilitates the study of its distribution in this animal. We removed the brain stems of twelve pigs (aged from one day to four weeks old), after perfusion of the head with 5 per cent formol–saline. Paraffin sections of Bielschowsky silver preparations were taken in both coronal and transverse planes. Transverse sections of the mid-brain at the level of the trochlear nucleus show the mesencephalic Vth root at maximum development. The bundles of the dorsal segment can be seen passing towards the trochlear decussation; lateral bundles, forming the greater curvature of the root, contain large heavily myelinated fibres descending to the sensory Vth root. In the ventral segment the fibres are much reduced in calibre; the bundles—larger here than elsewhere—decrease in number and ultimately merge into the medial longitudinal fasciculus.

Coronal sections through the dorsal aspect of the brain stem demonstrate clearly a mesencephalic Vth root contribution to the trochlear nerve. The dorsal segment of the root runs medial to the tecto-spinal tract, and, at the level of the anterior medullary velum, curves towards the aqueduct to enter the velum with the IVth nerve.

The origin of the oculomotor sensory component is more complex. We were unable to trace any direct connexion between the mesencephalic Vth root and the nuclei or fibres of the IIIrd nerve, and no sensory-type cells were seen in the nuclei or on the intra-cranial course of the issuing fibre bundles. There are here two possibilities to be considered: first (as suggested by Tarkhan), the passage of mesencephalic root fibres in the tecto-spinal tract, and their transference to the oculomotor bundles in the course of the tecto-spinal decussation; secondly, the existence of internuncial cell groups. The nucleus of Darkschewitsch and the interstitial nucleus may have special significance in this connexion, since they have been excluded by Warwick[3] from radicular participation in the oculomotor complex.

A further and more comprehensive investigation of the problem is now being undertaken. The work is assisted by a grant from the Medical Research Council of Ireland.

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Transplantation of Nuclei in Newt's Eggs

One of the most fundamental problems, both for genetics and embryology, is that of whether the genes in the nuclei of differentiated tissues retain their full range of capacities, or whether some irreversible alteration affects them. The most direct method of investigating this is to develop techniques which permit the transplantation of nuclei from differentiated cells of one kind into enucleated cells of different developmental potentialities. Briggs and King[1] have reported some attempts in this direction, in which nuclei from blastulæ or early gastrulæ of frogs were injected into uncleaved but fertilized frogs' eggs from which the zygote nucleus had been removed. Nuclei from blastulæ permitted the full differentiation of a normal embryo in a fairly high proportion of cases, those from early gastrulæ in a smaller proportion, whereas those from determined (but not yet differentiated) tissues gave little success, though it remained uncertain whether this was due to technical difficulties or to an incapacity of the genes.

During the past summer, we have carried out somewhat similar experiments with the eggs of the newt *Triturus palmatus*. Methods for removing the zygote nucleus from whole eggs have not been developed in this species. We therefore adopted the method of cutting the newly fertilized egg in half by laying a thin glass rod across it after removal of the vitelline membrane. The halved eggs were then left to complete the first two divisions; usually only one side, containing the zygote nucleus, underwent division, but in some cases (presumably when the egg at the time of operation was in anaphase) a nucleus was included in both halves, and both divided; such eggs were discarded. After it had been ascertained which half contained the zygote nucleus, one or more nuclei (accompanied by a little cytoplasm) were injected into the non-nucleated half. Cells for the injection were prepared by disaggregating portions of embryos in alkaline saline. An isolated cell was drawn into a pipette of a size suitable to break the cell membrane but to leave the nucleus intact, and injected as deeply as possible into the recipient cytoplasm. There was a tendency for the injected nucleus to emerge again as the pipette was withdrawn. When it was thought that this had occurred, a second nucleus was sometimes injected into the same egg. Operations were made in Holtfreter solution, and the injected eggs after healing were cultured in one-tenth strength Holtfreter.

Table 1. No. of Eggs Injected and Stage Reached

Eggs injected	Donor	Abnormal cleavage	Normal cleavage	Reached blastula stage
34	Blastula	9	10	5
61	Early gastrula	13	12	7
20	Late gastrula	2	9	6
34	Neural plate	4	13	0

The results are summarized in Table 1. It will be seen that a reasonably high proportion of injected eggs cleaved, but none of them succeeded in completing gastrulation, even when the injected nucleus came from a blastula. The eggs usually formed a spherical ball of cells, superficially like a late blastula; but the cells composing it did not adhere firmly to one another, and there was usually no proper blastocœl, the whole interior being filled by a mass of isolated spherical cells which were immediately extruded if the surface was slightly wounded. Nuclei from determined stages (gastrulæ with yolk plug or slit blastopore) gave results essentially similar to those from earlier stages. There is therefore no reason, from these experiments, for attributing the failure of gastrulation in the injected eggs to an incapacity in the nuclei of determined tissues. It seemed more probable that the technique in general was inadequate, perhaps because of damage done to

the surface coat. Preliminary attempts to overcome this have been made by transplanting the experimental blastulæ into the blastocœl of a normal embryo; but so far all such material has still broken down into isolated cells which suffer pycnotic degeneration of the nuclei within a short period. Some injections of nuclei have also been made into enucleated parts of eggs which remained within their jelly capsules and membranes. One of these showed some signs of forming a blastopore; but the tendency to break down into isolated cells was still not fully overcome. It is hoped, however, that in future work the technique can be improved by some such method as this.

One of us (E. M. P.) is grateful to the University of Edinburgh for a research studentship. The work received financial support from the Agricultural Research Council.

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Rapid Staining of Intestinal Amœbæ on Wet Mounts

In unstained preparations of intestinal amœbæ, the size, type of pseudopodia, movement and cytoplasmic inclusions enable one to distinguish the different species; but the characteristic staining of the nucleus leads to correct identification. For permanent preparations, hæmatoxylin staining and its various modifications are useful, but they are time-consuming. Hence various rapid staining methods have been advocated in recent years.

Experimenting with *E. histolytica*, *E. coli* and *E. terrapanae* obtained from cultures, and some of the rapid stains like Velat's[1], Quensel's[2] and J. S. B.[3], I noted that the *p*H of the staining solution was more important than the stain itself.

This was confirmed by using three buffer solutions on samples from cultures of amœbæ referred to above and also specimens of *E. histolytica*, *E. coli* and *E. nana* from patients. At certain *p*H-levels, the buffer solutions by themselves rendered the nuclei of trophozoites and cysts refractile, bringing out clearly all the morphological details. For the trophozoites of *E. histolytica*, the optimum *p*H with an acetate buffer was 4·0–4·8; with phthalate and citrate buffers, the *p*H required was 2·5–3·0. The vegetative forms also stained well with the different stains at various *p*H levels. The optimum *p*H for Velat's stain as 0·05 per cent solution in acetate buffer was 4·0–4·8, and with phthalate buffer it was 3·5. Solution I of J. S. B. stain prepared from the powder form[4] gave equally satisfactory results with acetate buffer at a *p*H of 3·5 and phthalate buffer 2·5 when used as a 0·1 per cent solution. Further, simple dyes like pyronine (1 per cent) and methylene blue (0·5–0·0125 per cent) in acetate buffer at *p*H 3·5 also produced the same results as Velat's and J. S. B. The cysts, however, required a low *p*H (1·25–1·35).

This work was carried out in the laboratories of the Parasitology Department of the School of Hygiene and Public Health, Johns Hopkins University, Baltimore, United States.

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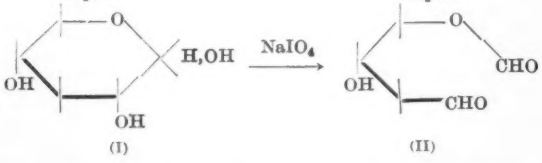
A New Synthesis of 2-Deoxy-D-ribose

A satisfactory synthesis of 2-deoxy-D-ribose, a sugar of very wide distribution in Nature, has not yet been achieved. Hitherto, the published synthesis with the highest overall yield is that of Deriaz, Overend, Stacey, Teece and Wiggins[1], who prepared it in yields of about 10 per cent from D-arabinose via D-arabinal. In an attempt to obtain improved yields of 2-deoxy-D-ribose, a partial oxidation of 3-deoxy-D-glucose with sodium metaperiodate was carried out. This reaction succeeded, but gave the desired product in only 29 per cent yield. This type of reaction, carried out under mild conditions, offers a method of preparation of derivatives of 2-deoxy-D-ribose from those of 3-deoxy-D-glucose.

In a trial experiment, 3-deoxy-D-glucose[2] (I) (62 mgm.) in water (25 c.c.) was oxidized with 0·19 *N* sodium metaperiodate (1·26 moles; 5 c.c.). Samples were taken at intervals and the uptake of periodate and formic acid production measured. The initial rapid uptake of periodate ceased after 190 min., by which time all the reagent had been consumed and only 0·51 mole of formic acid had been formed. Thereafter the formic acid titre was found to increase very slowly, only 0·56 mole of the acid being present after 600 min. The slow production of formic acid is probably due to the slow hydrolysis of 2-deoxy-4-formyl-D-ribose (II). This compound is stable to periodate, thus facilitating the isolation of 2-deoxy-D-ribose. The above type of reaction has been used by Fried and Walz[3] to prepare 2 : 5-di-0-methyl-D-arabinose from 3 : 6-di-0-methyl-D-glucose; by Barker and Smith[4] to prepare 2-0-methyl-D-arabinose from 3-0-methyl-D-glucose; and by Hemming and Ollis[5], who prepared 2 : 3 : 5-tri-0-methyl-D-arabinose from 3 : 4 : 6-tri-0-methyl-D-glucose.



(I) (II)

The 2-deoxy-D-ribose was prepared as follows. 3-Deoxy-D-glucose (0·337 gm.) was dissolved in a solution containing 0·19 *N* sodium metaperiodate (1 mole; 21·6 c.c.). After 3 hr., a 5 per cent solution of barium acetate was added, and the resulting precipitate was discarded. The solution was kept slightly alkaline by the dropwise addition of ammonium hydroxide until deformylation was complete (about 15 min.). The solution was then de-ionized by passage through columns of the ion-exchange resins

'Amberlite IR-120' and 'IR-4B'. The effluent was evaporated under reduced pressure to a syrup, which contained 2-deoxy-D-ribose and unchanged 3-deoxy-D-glucose. This was fractionated by chromatography on several large sheets of Whatman No. 1 filter paper[6] (solvent, butanol : ethanol : water, 40 : 11 : 19 v/v). The 2-deoxy-D-ribose was eluted from the appropriate strips of paper with cold water and the aqueous solution evaporated to a syrup (80 mgm.), $[\alpha]_D^{20} - 31°$ (*c*, 1·0 in water). The syrup was characterized by the formation of N-phenyl-2-deoxy-D-ribosylamine prepared by refluxing it in ethanolic solution with one equivalent of aniline[1]. The product, after two recrystallizations from ethanol, had melting point and mixed melting point 169–170°, $[\alpha]_D^{20} + 141°$ (12 min.) → + 47° (72 hr., constant value) (*c*, 0·40 in pyridine); and analysis gave C, 63·3; H, 7·2; N, 6·2 per cent; calculated for $C_{11}H_{15}O_3N$: C, 63·2; H, 7·2; N, 6·7 per cent.

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Amount of Gamma-Benzene Hexachloride picked up by Resistant Houseflies bred on a Medium containing Benzene Hexachloride

New information on the nature of resistance of the housefly, *Musca domestica*, to benzene hexachloride (BHC) was obtained in the course of experiments comparing the pick-up of gamma-benzene hexachloride by normal flies (Hawthorndale stock) with that by a strain having very high resistance to this insecticide.

The resistant flies originated in Uruguay, but had since been reared through many generations to yield a strain the larvæ of which were able to tolerate 0·5 per cent gamma-benzene hexachloride in their food. Those here considered had been reared throughout their larval life on a diet containing this amount of toxicant. The pupæ were removed by flotation, and the flies, which were allowed to emerge in clean jars, were fed on uncontaminated milk and sugar.

Three days after emergence the adult flies were exposed to deposits of carbon-14 labelled gamma-benzene hexachloride on filter paper inside a Petri dish for periods varying from 15 min. to 16 hr. The benzene hexachloride picked up was separated as two fractions, 'outside' and 'inside', using a technique similar to that described by Armstrong, Bradbury and Britton[1]. The 'outside' fraction, obtained by rinsing the insects with carbon tetrachloride, we regard as being in the superficial layers of the epicuticle; the 'inside' fraction, obtained by grinding the rinsed insects with anhydrous sodium sulphate and extracting with carbon tetrachloride, comprises the insecticide in the internal insect tissues. Both fractions were determined by combustion to carbon dioxide, which was isolated as barium carbonate for counting. Results of several experiments, each with twenty female flies, are summarized in Table 1.

Table 1. Amount of Gamma-Ben ene Hexachloride picked up by Flies (in μgm./gm. Fly) determined Radiochemically

Time of exposure (hr.)	Non-resistant			Resistant			Difference between totals
	'Outside'	'Inside'	Total	'Outside'	'Inside'	Total	
½	13	11	24	5	1	6	18
1	19	21	40	13	8	21	19
2	17	26	43	15	15	30	13
4	19	34	53	20	32	52	1

It is clear that in the first two hours, resistant flies picked up less carbon-14-labelled benzene hexachloride than normal flies, both 'outside' and 'inside'.

As it was possible that the resistant flies already contained benzene hexachloride transmitted from earlier stages (Hoskins[3] has observed such an effect with DDT-resistant flies). adults and puparia from larvæ reared on a medium containing benzene hexachloride were analysed, using the colorimetric method described by Armstrong, Bradbury and Standen[2]. It was found, from two determinations on a total of 150 puparia and 150 female flies, that gamma-benzene hexachloride was present in the intact puparia to the average amount of 40 μgm./gm. fly and in the adults to 17 μgm./gm. fly. This is enough in the adult to account for the difference between that picked up by the resistant and non-resistant flies.

It may be argued from these results that: (1) resistance to gamma-benzene hexachloride by houseflies is not due to resistance to penetration of the insecticide; (2) a detoxification mechanism is unlikely in flies resistant to benzene hexachloride, since these carry over in their tissues from the larval stage enough insecticide to kill normal flies in a few minutes.

A detailed account of this work will appear elsewhere. We are indebted to our colleagues at Widnes Laboratory, Messrs. R. Hill, F. P. Johnson and C. Whimpenny, for the synthesis of benzene hexachloride from carbon-14-labelled benzene and the separation of the isomers by chromatography. Mr. H. Standen carried out the colorimetric analyses.

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Unit Cell and Preliminary Structure for Cellulose Triacetate

ALTHOUGH interplanar spacings for cellulose acetate II have been published[1,2], I have been unable to trace a determination of the unit cell or space group.

Small films of highly crystalline triacetate with good fibrous orientation and a fair degree of biaxial orientation have been prepared by repeated rolling at successively higher temperatures between 160° and 215° C. The higher orientation was somewhat improved by swelling in glacial acetic acid, followed by drying at 110° C. while maintaining the sample under pressure. Figs. 1*a* and *b* are X-ray diffraction photographs of such films showing several new spacings. On the perpendicular photographs along the equator, there are reflexions with the spacings 24·50 and 12·25 A., and on the first level there is a 9·61-A. spacing. On the parallel photograph there is a faint 5·78-A. spacing along the equator. It can be seen that the fibre orientation is better in a plane containing the fibre axis and a perpendicular to the plane of the sheet, than in the plane of the sheet.

The additional data have made it possible to index all spots on the basis of an orthogonal unit cell containing four cellobiose hexa-acetate residues. The dimensions of this unit cell, taking [00*l*] as the fibre direction, are $a = 24{\cdot}50$ A., $b = 11{\cdot}56$ A. and $c = 10{\cdot}43$ A. The theoretical density is 1·30 gm./c.c., and this compares with 1·29 gm./c.c. observed for a fairly well-crystallized sample. Thirty reflexions have been indexed on this basis, and all have spacings in agreement with those calculated to within 1 per cent.

The orthogonal cell and the symmetry of the photographs suggest a space group of the orthorhombic system. The (*h*00), (0*k*0) and (00*l*) reflexions, except for a weak (100), are apparently absent for *h*, *k* or *l* odd. The presence of (100) suggests the space group, $P22_12_1$, if the screw axes in the *b*- and *c*-directions are regarded as real. Other orthorhombic possibilities are $P222$, $P22_12$ and $P222_1$. All these space groups have a two-fold axis in the *a*-direction, but it appears to be impossible to set up a model with two pairs of cellulose chains related by such a two-fold axis and which will give rise to a weak (020) reflexion. It was therefore decided that cellulose triacetate is only pseudo-orthorhombic and the probable space group is $P2_1$, but that it may be closely approximated by $P2_12_12_1$.

In the case of cellulose I and II, the cellulose chains are necessarily coincident with the 2_1 axes, but this is not a requirement in this case. In one model based on $P2_12_12_1$, which gives promising agreement with the intensities, the cellulose triacetate chains are paired about a c_2-axis, with the planes of the glucose residues parallel to one another and inclined at about 45° with respect to *a*. The adjacent c_2-axes then have similar pairs of chains directed in the opposite direction and inclined at about − 45°.

The intensities are quite sensitive to the positions of the acetyl groups, and a refinement of this model promises considerable structural detail which will be published elsewhere.

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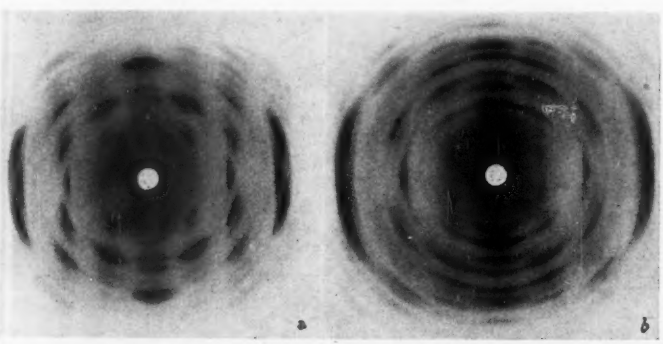

Fig. 1. X-ray diffraction pattern of highly oriented crystalline cellulose triacetate. Copper *Kα* monochromatic radiation. (*a*) X-rays parallel to the plane of the sheet. (*b*) X-rays perpendicular to the plane of the sheet

Production of Magnetic Fields in Liquid Mercury by Mechanical Motion

IN connexion with recent attempts by Alfvén, Biermann, Batchelor *et al.*, to explain stellar and interstellar magnetic fields, we have considered the possibility of producing electric currents and magnetic fields in liquid mercury by suitable mechanical motion.

Our experiments are arranged as follows. In a cylindrical vessel filled with mercury we have rotated the upper half by means of a stirrer, while the lower half was prevented from rotation by means of radially fixed vanes on the bottom. The angular velocity of the mercury in the upper half was fairly high (about 20–35 c./sec.) and slowed down to zero in the lower part of the vessel. Accordingly, there exists a rotational and toroidal flow of liquid mercury. The present research is restricted to the action of the toroidal flow only. In the absence of any outer magnetic field, the electrons appear to go somewhat ahead of the ions, so that there results a toroidal electric current causing a circular magnetic field around the axis of rotation. We have succeeded in detecting this magnetic field and find a value of 10^{-4} gauss, which seems to fit reasonably well with theoretical expectations.

It may seem difficult to screen off the magnetic field of the earth to less than 10^{-4} gauss over the whole area involved. Indeed, using large Helmholtz coils and enclosing the whole apparatus in a box of suitable screening material, there still remained a field of the strength of some 10^{-4} gauss. But fortunately the effect described above can be separated quite simply from the influence of the earth's magnetic field, as the former increases with the square of the speed of rotation, the latter linearly. Reversing the sense of rotation causes the two effects to be added or to be subtracted. This easily enables the evaluation of the magnetic field-strength created within the

circulating liquid. Details of the experiments will be communicated soon in the *Zeitschrift für Physik*.

The production of the magnetic fields can be easily understood, regarding the electrons as having a free mean path within the liquid mercury. The electrons will appear at any point A with a velocity they have gained from the last impact at a different point B. Whenever a circulating flow of a liquid has a velocity gradient which is not linear, as is often the case in pipes, etc., the diffusion of the electrons causes an electric current in the direction of the flow and accordingly a magnetic field. For a rotational motion, the electric field producing the current observed cannot be compensated by the Coulomb forces of any space charges.

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Magnetic Fields measured within Flames brought mechanically into Rotational Motion

The flame of an oxygen burner was brought into spinning motion by forcing the gas tangentially into a cylindrical tube. The gas inlet is interrupted at frequent intervals in order to produce separate whirls of burning gas, which move along inside the tube one after the other. An induction coil surrounding the tube shows the existence of toroidal magnetic fields moving along together with (that is, surrounding) the plasma whirls. From the magnetic field we conclude that there exist electric currents within the plasma whirls accompanying the motion of the plasma.

Very careful experiments extending over several years show clearly that these currents can be attributed to the velocity difference of ions and electrons within each whirl. The electrons are retarded relatively to the ions because of their enhanced diffusion velocity into and back from cooler portions of the gas.

Quantitative measurements have been made in these experiments. From a determination of the temperature by several independent spectroscopic methods, the degree of ionization can be evaluated. An independent determination of the latter is obtained using the conductivity of the gas, which can also be measured and was found to reach values of the order of 10^{-11} e.s.u. if metallic potassium was introduced into the flame.

The induction coils were calibrated by means of a simple loop of wire, connected to an oscillatory device. For calibration the wire was put into the tube in place of the gas whirls. The measured toroidal magnetic field-strength created from the plasma whirls was found to be of the order of magnitude of 10^{-4} gauss.

The influence of magnetic fluctuations other than those created inside the tube was eliminated by using two identical coils connected in such a way that magnetic influence upon one coil only is to be registered. Compensation of the earth's magnetic field and application of an external field three times that of the earth causes only the zero level of our registration to shift up and down without altering the magnitude of the effects measured. Many other tests of the reality of the magnetic fields measured have been carried out.

Reduction of the speed of rotation causes the effect to decrease, becoming zero with no rotation at all. Decrease of the conductivity with less potassium added causes the effect to decrease likewise. Details of the experiments will be communicated in the *Zeitschrift für Naturforschung*.

The experiments described here and in the preceding communication deal with two different ways of creating magnetic fields within a 'plasma' by mechanical forces only. The first one deals with a plasma of practically zero compressibility, the latter with a compressible gas. In the latter, the experiments support the theory developed by Biermann and Schlüter[1] *et al.* and are obviously analogous to astrophysical phenomena.

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Recovery of Isotopic Boron and Lithium from Nuclear Research Emulsions

Nuclear research emulsions are sometimes loaded with the stable isotopes of boron or lithium for work on nuclear disintegrations or on neutron counting by the photographic plate technique. Since the usual additions correspond to as much as 16 mgm. lithium or 23 mgm. boron per c.c. of emulsion, and these amounts of isotopes of low natural abundance are costly, the technique is expensive unless the isotope can be readily recovered after plate exposure.

Two series of spectrographic analyses have, therefore, been made on the solutions from the usual processing sequence on nuclear plates coated with 200 μ thickness of emulsion and loaded with natural lithium sulphate and boric acid respectively. It was found that pre-soaking for one hour in distilled water extracted 90 per cent of the boric acid, the remainder being found in the developer (50 min. development). In the case of lithium sulphate, two-thirds was found in the pre-soak, one-third in the developer and a small amount in the 10 per cent potassium bromide stop-bath (30 min.). There was no detectable boron or lithium in the remaining solutions or in the gelatin, so almost complete recovery can be achieved very simply from the pre-soak and developer solutions.

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Crystal Structure and Magnetic Properties of Cobalt Ferrite at Low Temperatures

Cobalt ferrite ($CoO.Fe_2O_3$) and magnetite ($FeO.Fe_2O_3$) both crystallize at room temperature with the inversed-spinel-type of structure[1]. A magnetic transition consisting of an abrupt decrease of saturation magnetization takes place in magnetite[2]

at 116° K., and is accompanied by a slight deformation of the structure cell from cubic symmetry above the transition to approximately rhombohedral symmetry below[3]. As cobalt ferrite[4] undergoes a similar magnetic transition at 90° K., we might expect that, like magnetite, it is no longer cubic below its magnetic transition temperature. We have shown by means of X-ray powder photography that this is indeed true, but the departure from cubic symmetry is even smaller than in the case of magnetite. Our results indicate that the structure cell of cobalt ferrite at low temperatures is approximately tetragonal.

Powder photographs were taken at liquid nitrogen temperature (80° K.) with a 19-cm. camera; both cobalt $K\alpha$ and iron $K\alpha$ radiations were employed. Several different specimens were prepared by mixing appropriate proportions of pure CoO and αFe_2O_3, and firing the mixture in air for several hours at 1,100° C. The departure from cubic symmetry was revealed by splitting of some of the high-order, originally cubic lines. The cubic 840 and 800 reflexions were each split into two components with intensities approximately in the ratio 2 : 1, in order of increasing Bragg angle. No splitting of the high-order 444 (iron $K\alpha$) and 555 (cobalt $K\alpha$) reflexions could be detected.

This behaviour indicates that there is a principal dilatation along a [100] direction, so that the structure cell is approximately tetragonal with c/a slightly less than unity. This interpretation requires 840 to be split into three tetragonal components (840, 804 and 408); but the first two of these are too close together to be resolved. In the accompanying table we give several independent values of c/a, deduced from measurements on split cubic reflexions. These values are in fairly good mutual agreement. In view of the extreme smallness of the lattice deformation, it would be of interest to study the line splitting in more detail by means of a sensitive counter spectrometer.

Cubic reflexion	Tetragonal indices	Wave-length	Value of c/a
800	800, 008	Iron $K\alpha_1$	0·99868
800	"	Iron $K\alpha_2$	0·99870
840	840 {804 408	Cobalt $K\alpha_1$	0·99885

We believe that the X-ray results on Fe_3O_4 and $CoFe_2O_4$ at low temperatures are relevant to the interpretation of the low-temperature magnetic transitions. The changes of symmetry take similar forms to those observed in FeO and CoO respectively, as these monoxides are cooled below their antiferromagnetic Curie temperatures[5]. Thus FeO and $FeO.Fe_2O_3$ are both rhombohedral at low temperatures, with the rhombohedral angle α_R slightly less than 60°, and CoO and $CoO.Fe_2O_3$ are both tetragonal with c/a slightly less than unity. Verwey's theory[6] of the origin of the low-temperature transition in magnetite involves an ordering of the valency electrons in the octahedral sites. His model requires a low-temperature tetragonal symmetry, whereas the observed symmetry is more nearly rhombohedral. The observed low-temperature symmetry in cobalt ferrite is tetragonal, but Verwey's model cannot explain this as electronic interchange between Co^{3+} and Fe^{3+} is more or less inhibited. We conclude that Verwey's theory cannot explain the origin of the low-temperature transitions in either magnetite or cobalt ferrite. The correct solution may be found by considering the close similarity of their structural behaviour with that of the corresponding simple monoxides.

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Formulation of the Velocity Constant in Chemical Kinetics

Much information on chemical kinetics has been accumulated in recent years. In many cases it is of high precision and of proved exactness, so that comparisons may be made with a fair degree of satisfaction of data presented for similar systems. Further, the exactness of some of the data makes it possible to use information obtained by different authors as a basis of further calculation. In view of these statements, it may be surprising to realize that the basic measurement in such studies, namely, the velocity or rate constant, lacks a logical and unique definition.

Existing definitions may be based on the rate of disappearance of reactants, or alternatively, on the rate of appearance of products. Even if one attempts to maintain a consistent definition based on reactants, difficulties arise. For example, a reaction step which may be written kinetically as:

$$2A + B \rightarrow X, \qquad (1)$$

where A, B and X are atoms, radicals, or molecules, may define two velocity constants as follows:

$$-\frac{d(A)}{dt} = k_1(A)^2(B); \quad -\frac{d(B)}{dt} = k_2(A)^2(B). \qquad (2)$$

Since the rate of removal of A is clearly twice that of B, it follows that $k_1 = 2k_2$, the concentrations of the reactants being expressed in common units. Thus, to assess the precise meaning of such a velocity constant, it is necessary to examine carefully any kinetic analysis which has been attempted. This applies also to a definition based on products.

It is here suggested that the velocity constant should be based not on reactants or products, but on the intermediate complex formed. Thus in the above example, the intermediate complex would have the formula A_2B, so that the rate at which units of reaction occur would be $k_3(A)^2(B)$, that is, rate at which two molecules of A react with one molecule of B to form one molecule of X. With this definition, it is now possible to write:

$$-\frac{d(A)}{dt} = 2\,k_3(A)^2(B); \quad -\frac{d(B)}{dt} = k_3(A)^2(B). \qquad (3)$$

This simplification of the formulation of the velocity constant is of importance in the case of a reaction involving, say, the mutual destruction of two radicals, a process well known in many chemical studies. For example:

$$A + A \rightarrow A_2 \quad k_4 \qquad (4)$$
$$A + B \rightarrow AB \quad k_5. \qquad (5)$$

Using the suggested system,

Rate of reaction (4) $= k_4(A)^2$;

$$-\frac{d(A)}{dt} = 2\,k_4(A)^2.$$

Rate of reaction (5) $= k_5(A)\,(B)$;

$$-\frac{d(A)}{dt} = -\frac{d(B)}{dt} = k_5(A)(B).$$

These reactions are of similar type and therefore it is of interest to compare the values of k_4 and k_5 ; but first it must be remembered that these velocity constants contain a collision number—the rate of collision for reactants at unit concentration. These collision numbers Z_4 and Z_5 differ by a factor of 2 (changes in collision cross-section and mass being usually a second-order change), as derived from the classical kinetic theory :

$$Z_4 = 2\sqrt{\pi}\,N_A{}^2 d_A{}^2 \sqrt{RT/M_A}$$

$$Z_5 = 2\sqrt{2\pi} N_A N_B \left(\frac{d_A + d_B}{2}\right)^2 \sqrt{\frac{M_A + M_B}{M_A M_B}} \cdot RT.$$

Thus it will be seen that the best comparison of the two processes must recognize that $Z_5/Z_4 \sim 2$. The comparison is most easily achieved by referring to the appropriate collision efficiencies, since the collision efficiency is defined as being equal to k/Z.

Theoretical calculations of rates of chemical reaction almost invariably involve the velocity constant in the sense suggested here, and it is proposed that experimental values should be brought into line logically in the manner discussed above.

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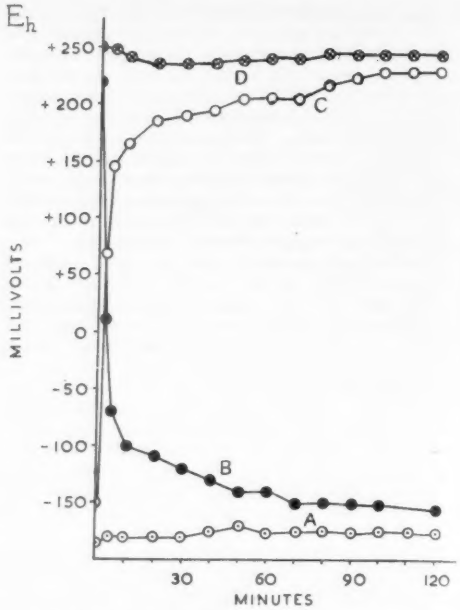
Time-Lag in E_h Potentials

Electrode potentials are measured in order to indicate the state of the electromotive equilibrium of bacterial cultures ; equilibrium depends on the activity between the cellular enzymes and the constituents of the medium. It is generally agreed that methods of measurement are still empirical. For rapidly growing cultures Hewitt[1] suggests half-hourly readings ; but it may not be realized that with the usual method[2] the recorded readings do not represent the true E_h at the time of measuring. This can be shown by the following experiment in which an electrode is subjected to rapid changes in E_h.

Two identical electrodes were used : one was continuously immersed in a medium of a given E_h, and the other was brought into this medium, having previously been kept at a different E_h level. The change-over was effected without exposing the surface of the electrode to air. A low E_h system was obtained by autoclaving a 1 per cent peptone solution of *p*H 7·6 containing 0·25 per cent sodium thioglycollate. This solution was placed in a wide test-tube, forming a column of about 5 in. A small glass tube filled to the rim with the same medium, but without the reducing agent, was suspended by wire above the larger tube. Mercury–platinum electrodes (20 s.w.g. platinum wire, 15 mm. exposed length) were placed into each tube, and after a lapse of two hours to allow for stabilization, readings were taken. The electrode continuously immersed in the reduced system is labelled *A* in the diagram. The small tube



carrying electrode *B* was then lowered below the surface. The small tube was carefully removed without mixing, and electrode *B* was placed alongside *A*. The lag in registering the sudden alteration in the E_h level is well shown. The small admixture of peptone water in the process of transfer did not appreciably alter the E_h as shown by electrode *A*.

The reverse experiment was also performed with substantially the same results. The reduced system was placed in the small tube (electrode *C*) and the peptone solution in the large tube (electrode *D*).

It is clear that a true E_h reading is not obtained within two hours. This is a particularly serious source of error when the behaviour of bacterial cultures is followed. On account of the lag, the initial fall is, in fact, steeper than one would be led to believe. When continuous readings are taken of rapidly altering biological systems, this lag, which is inherent in the method, should be considered.

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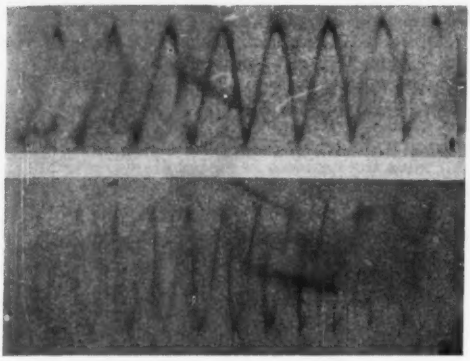
A Sealed-off Cathode-Ray Tube with a Very High Writing Speed

An experimental cathode-ray tube of the sealed-off type has been constructed for the purpose of visual observation and photographic recording of non-recurrent high-voltage transient phenomena, with sweep speeds in the milli-microsecond range.

This tube is of the 6-in. flat-faced type, and has an aluminized screen with a highly actinic blue phosphor. The beam is magnetically focused and electrostatically deflected. An incoming signal is fed into



a straight twin-wire transmission line which passes through the tube in a direction perpendicular to the tube axis, and which forms the vertical deflector system. This design considerably reduces the transit time of the electron beam in the deflector field and, at the same time, enables the deflector system to be correctly matched with the signal generator and connecting system. The low-frequency deflexion sensitivity was found to be 0·006 mm. per volt at a beam-accelerating voltage of 25 kV.

The performance of the tube is illustrated in Fig. 1, which is a photograph of a 9,500-Mc./s. oscillation displayed on a single sweep time-base of 1·3 μsec. duration. It is of interest to note that in this photograph the writing speed of the electron beam at the screen phosphor has a maximum value of about 4×10^{10} cm. per second (1·3 c) with a trace width of 0·2 mm. Fig. 2 shows an oscillation of the same frequency but with an increased amplitude and a maximum writing speed of $6{\cdot}6 \times 10^{10}$ cm. per second (2·2 c) with a trace width of the order of 0·5 mm. The original oscillograms were not suitable for reproduction here, but the trace could be clearly seen and measured. The records suggest that under these conditions of operation, with the tube in its present form, the useful horizontal sweep is limited to about 4 cm. because of defocusing. The photographs were taken with a Wray $f1$ copying lens on Ilford 5G91 film, developed in Johnson's Contrast developer and printed on Ilford Grade 5B paper.

An improved version of the tube is now being prepared, and it is anticipated that a further advance on the writing-speed performance will be made. Further investigations are also being carried out to determine the ultimate writing speed of various screen phosphors.

More complete details of design and tube performance and of the milli-microsecond time-base circuit will be published elsewhere.

We wish to acknowledge assistance given by Ferranti, Ltd., in the Physical Laboratory of which the tube was constructed. One of us (B. J.) would like to acknowledge financial assistance given by the Department of Scientific and Industrial Research.

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Saw-toothed Wave-forms in Sound

Using an improved form of apparatus previously described by Timbrell[1], one of us (T. F. W. E.) has found certain anomalies in the rate of distortion of sound pulses of finite amplitude propagated in air contained in a wide tube. This communication is concerned with the behaviour of those sound pulses of finite amplitude in which the leading half-cycle of the wave is one of rarefaction. This type of wave-form could be formed in either of two ways: (*a*) by direct generation at a loud-speaker placed at one end of the propagation tube, or (*b*) by the reflexion of a leading compression pulse (generated by the loud-speaker) at the end of the tube when it is open to the atmosphere—the back-travelling pulse will have a leading rarefaction due to phase-change at reflexion.

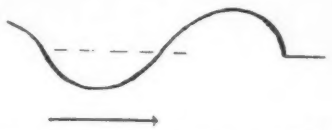

Fig. 1. Pressure-time curve of a sinusoidal pulse with a leading rarefaction

Stokes[2] predicts that a rarefaction wave train as in Fig. 1 will become distorted during propagation in such a way that the rarefaction and compression peaks will approach each other. The central region will correspondingly become steeper and the head and tail regions less inclined, and ultimately a discontinuity or shock will be formed (see Fig. 2). The rate at which this process of distortion takes place may easily be calculated from a knowledge of the pressure or particle-velocity amplitudes in the wave. We have found that the observed experimental value of the decay confirms the rate predicted by Stokes's theory only when the wave is generated by method (*a*) above.

If a continuous wave-form of initial rarefaction is generated by method (*b*), it is found that it does not contain any discontinuity in its central region after such a time that a shock should be present according to Stokes's theory. It is, in fact, still approximately sinusoidal (see Fig. 3). More detailed measurements by one of us (T. F. W. E.) have shown that the wave does suffer distortion throughout its propagation away from the open end of the tube but at a much reduced rate.

This anomalous behaviour may be attributed to the process of reflexion at an open end. The process is too complex to be analysed in any detail here; but briefly (see also a recent paper by Chester[3]), the reflected wave is to be regarded as the superposition of a large number of singly and multiply diffracted and reflected waves formed by the edges and walls of the

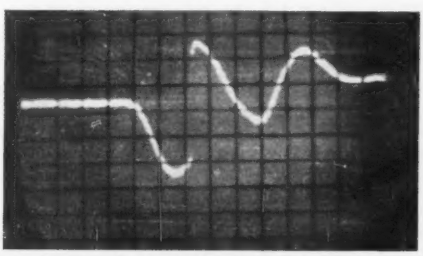

Fig. 2. Experimental record of a rarefaction pulse after propagation through 2 metres, showing very marked discontinuity

Fig. 3. Rarefaction pulse formed by method (*b*) measured at 2 metres from open end

tube near its open end. Even some distance along the propagation tube from the open end, the many wave-fronts of these secondary waves are not perpendicular to the tube axis and are still altering their relative orientations. Only at an infinite distance from the open end does the reflected wave system become geometrically stable, and only then is it permissible to compare the experimental results with theory.

So far as is known, the occurrence and behaviour of sound pulses of finite amplitude in which the first half-cycle is one of rarefaction have not previously been recorded in the literature. The reflexion of a compression pulse at any boundary of decreasing acoustic impedance will give rise to a wave of the type described here; for example, an underwater explosion reflected from the free surface of the water. It also seems probable that such a rarefaction pulse might be formed as a result of cavitation phenomena.

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Sequential Sampling in Biological Assay

In an investigation relating to the isolation and purification of chorionic gonadotrophin from pregnancy urine, the following problem has arisen: "Does fraction *A* contain at least the amount *X* of chorionic gonadotrophin?" It was necessary to answer this question in the shortest possible time and to use as little material of *A* as possible. As the solution of this rather specialized problem may have a much more general application to researches of similar nature, it is felt to be worth communicating.

For simplicity, arbitrary concrete figures will be given in the following. Substance *A* was to be tested for the hypothesis that its chorionic gonadotrophin content was equal to or greater than 100 I.U. per mgm.; if so, it was to be accepted; if it contained less than 100 I.U./mgm. it was to be discarded. The tolerated risks with regard to the precision of the estimate were fixed at 80–125 per cent, and with regard to the probability of making a wrong decision were allowed to be 5 per cent, no preference being given to either errors of the first or second kind. That is to say, only in five out of two hundred cases would the substance be rejected if it contained 125 or more I.U. chorionic gonadotrophin/mgm., and in only five out of two hundred cases would it be accepted although it actually contained 80 or less I.U./mgm.

In principle, the problem thus defined is a common one in sampling inspection, and a sequential test[1] seemed most likely to meet the requirements. In the present case the problem is complicated, since no chemical method is suitable and a biological assay method has to be adopted; the spermiation test utilizing male toads[2] was chosen.

To solve the problem as stated above, substance *A* was assumed to contain 100 I.U. chorionic gonadotrophin/mgm., and the median effective dose (*ED* 50), according to this assumption, was injected into male toads (*Bufo viridis*). The toads were taken at random from a population the dose-response curve of which for chorionic gonadotrophin had been established not more than one month before. This seemed justifiable in view of the fact that the slope of the regression line (plotting probit of percentage reactors against log dose) had remained constant within sampling error over a period of two years, and no significant shift of the regression line was ever observed within a period of up to five weeks[3]. The percentage of expected non-reactors (that is, toads with no spermatozoa in their urine 3 hr. after the injection), when given 80 and 125 per cent respectively of the *ED* 50, was read off the regression line and was found to be 73 and 27 per cent respectively. Thus, in terms of a sequential test—adopting Wald's[1] notation, p denoting the fraction of non-reactors—the following values were obtained: $p_0 = 0{\cdot}27$, $p_1 = 0{\cdot}73$, the probability of committing an error of the first (α) or second (β) kind being $\alpha = \beta = 0{\cdot}025$. Consequently, the hypothesis, that the toad population subsequent to the injection of what was assumed to be the *ED* 50 consisted of 50 per cent or more reactors, was tested against the alternative hypothesis that it contained less than 50 per cent reactors. Thus the test showed whether the dose of chorionic gonadotrophin each toad had received was, in fact, equal to or greater than *ED* 50, and consequently, whether the amount contained in substance *A* conformed to the requirements for its acceptance.

The actual test was carried out according to standard sequential sampling procedures. Acceptance and rejection numbers were calculated, and the test was terminated as soon as the number of non-reactors agreed with either the acceptance number or the rejection number. Furthermore, to arrive at a decision within 24 hr., grouping was adopted (four toads being tested at a time), and the test was truncated if no decision was obtained after the eighth sample (that is, after a total of thirty-two toads had been injected and inspected 3 hr. afterwards). Calculation of the average sample number function showed that, on the average, a decision was to be expected after one to four samples, depending on the amount of chorionic gonadotrophin actually contained in the test substance. The actual results were consistent with these theoretical expectations.

Several points, for example, the most practical grouping, the effect of truncation on the probability of making a wrong decision, etc., are still under examination. The results of these investigations will be published in more detail elsewhere.

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Family Antigens or 'Private' Blood Groups and the Sub-Group of A–A_4

FAMILY antigens or 'private' blood groups are defined by Levine[1] as being "characterized by the positive or negative reactions being limited to members of a particular family".

Levine reviewed five such antigens, van Loghem and van der Hart[2] have reported a sixth and Holman[3] a seventh, and others are often discussed among blood-group workers. Recently, Chown[4] pointed out how the literature might have received the report of yet another 'private' blood group had not a search been made among bloods of races other than that race in which the antibody occurred. In Chown's case, a North American Indian woman had an antibody against her husband's red cells but it failed to react with the red cells of 794 other Indians. However, when the serum was used against red cells from Caucasians, it was shown to be *anti-Kell*.

Chown, considering a recent lecture[5] on the sub-groups of A, has suggested my directing the attention of other blood-group serologists to another possible fallacy.

Mr. J. had given blood on many occasions and had been regularly reported as group O. He was considered as such when a hospital reported to these laboratories that his blood was incompatible with the serum of a Miss R., a nullipara without transfusion history. Mr. J.'s cells were tested with anti-A and anti-B with no reactions occurring; his serum agglutinated both pooled A and pooled B cells, that is, he was regrouped as O. Miss R.'s serum strongly agglutinated Mr. J.'s cells, his father's and one of Mr. J.'s children. Attempts were made to identify the antibody in Miss R.'s serum by testing it against several hundred group O bloods, all of which were compatible.

Samples of Mr. J.'s blood and Miss R.'s serum were sent to other blood-group workers and they confirmed Mr. J. as group O and his cells to contain a unique antigen—the Jackson antigen—to which Miss R. had the antibody. The paper was prepared for publication, and what appeared to be a clerical error in the protocols necessitated the examination of further specimens from Mr. J. and his children.

Since first testing Mr. J.'s blood with Miss R.'s serum, the method of *ABO* grouping had been altered in these laboratories. A precipitin tube technique had always been used, and the serum tested against pooled A and pooled B cells. However, as an additional check we started testing the red cells with group O serum. This additional test revealed a blood which gave the following reaction:

Red cells				Serum	
Anti-A	Anti-B	Anti-AB (Group O)	A cells	B cells	O cells
—	—	++	+	+	−

It will be seen that without the use of group O serum this blood would have been classified as group O. Subsequent tests showed that this blood was of the type A_4 described by Gammelgaard and Marcussen[6]. Fuller reports[4] on these bloods have been published elsewhere, but briefly they (1) give little or no reaction with anti-A sera; (2) are agglutinated by all group O sera; (3) their sera contain an agglutinin against A_1 and A_2 cells strongly active at 20° C., in addition to anti-B.

On receiving the requested specimens from Mr. J. and his children, they were tested fully for all red cell antigens, and in *ABO* grouping their red cells were tested with group O serum. Surprisingly, the cells of Mr. J. and one of his children gave strong agglutination with group O serum. They were soon confirmed as A_4 and it was realized that Miss R.'s serum contained no unique antibody and that the testing of hundreds of group O bloods had not been the search for the so-called "Jackson antigen" but for another A_4, the occurrence of which among British people is about 1 in 30,000.

It is strongly recommended that: (1) all so-called family or private blood groups be tested with group O serum (in the course of investigations the Levay[7] and Graydon[8] bloods have been tested with group O serum, and these are not A_4 bloods); (2) group O serum is an essential reagent in *ABO* grouping; (3) the racial origin of both the donor of the family antigen and the corresponding antibody be considered (in reporting the latest family antigen—the Wright antigen—Holman[3] failed to consider the racial origins of the family); in this respect, Shapiro[9] has reported A_4 bloods as common among Bantus, and Caucasian × Bantus mating could well lead to a similar set of circumstances to Chown's but involving the A_4 antigen and not the *Kell*.

My thanks are due to Dr. C. C. Bowley, director of these laboratories, for permission to publish this communication.

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Sea Foam

IN a recent article[1] on the persistent sea foams that may be cast up on the shore during stormy weather, Miss E. C. Pope has suggested that protein debris from damaged planktonic organisms and alginates from sea-weed may be responsible for the formation and stability of the foam.

The late Prof. J. H. Orton was much interested in the phenomenon of sea foam, and wondered if considerable amounts of plankton and organic debris might not be brought ashore by this means (and by wave-action in general) to form a source of food for limpets and other intertidal animals. At his instigation I made a few preliminary observations on sea foam; the results may be of interest in comparison with the Australian observations.

Samples of the foam cast up on the shore at Kallow Point, Port St. Mary, Isle of Man, in December 1948 and April 1949, were collected in screw-topped jars and allowed to settle for 24 hr. It was found that 0·5 litre of foam reduced to 5 c.c. of an opalescent yellow-brown fluid, which deposited flocculent brown particles on standing, and had a typical 'shore' smell, similar to that of sponges and sea-weed. Microscopical examination of the fluid showed the presence of particulate matter of various sizes. Of the few recognizable particles, some were of obvious planktonic origin, for example, parts of copepod cuticle, diatom frustules, and green flagellates, but others were of littoral or benthic origin, such as sponge

spicules, foraminiferan shells and algal fragments. However, the majority of the particles were unrecognizable, varying from 0·5 to 10 μ in diameter, but mostly about 1 μ (that is, of just colloidal dimensions), and showed a strong tendency to form a layer at air/water interfaces.

After drying at 105° C., 4 c.c. of the residual fluid reduced to 0·17 gm. of total solids, of which 0·135 gm. was due to the salt present in the water, leaving 0·035 gm. of other solids probably corresponding to the particulate matter. The dried residue was tested for cellulose, protein and pentose with negative results. Both protein and pentose (among other substances) can produce stable foams by adsorption in the form of a rigid interfacial layer; but since this layer need be of only molecular thickness, the amount of stabilizing material does not have to be very large, and might remain undetected by the methods used. However, it was obvious that the food content of the foam was negligible compared with that already available on the shore.

While the evidence obtained was partly in support of Miss Pope's suggestions[1], there was no evidence that the apparent stabilizing particles were derived from living organisms broken up by the waves: they might have originated from detritus or fæcal matter. Furthermore, it does not seem essential to postulate the presence of a substance causing marked lowering of the surface tension. The properties associated with foam formation appear to be surface rigidity and a sharp rise in surface tension when the surface area is increased, rather than low surface tension by itself[2]. It is possible that the drag of the wind on the water compressing the surface film and causing it to 'solidify' is a contributory factor towards the formation of foam.

I am indebted to Dr. D. J. Crisp for advice on this matter.

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Wave Riding of Dolphins

Previous discussions[1] of the wave riding of dolphins have been based on the assumption that it was necessary for a dolphin to have a weight greater than that of the displaced water in order to be able to ride a wave while totally immersed. It is the purpose of this communication to clarify this point and to show that it is the total weight of the dolphin which is significant rather than the excess weight.

From the hydrodynamic point of view, it is most convenient to consider the steady-state case in which the dolphin and the wave are stationary and the main body of water is moving with the wave velocity. Within the linearized theory of steady waves, streamlines of the flow are lines of constant pressure, and this relation may be expected to hold approximately for any steady-wave system. The simplest correct approximate way of computing the ideal force on an immersed body in such a flow is as a buoyant force, equal to the volume times the pressure gradient evaluated at the centre of the immersed volume. This pressure gradient equals the fluid density times ($g \cos\theta + u^2K$), where u is the local velocity of the flow and θ and K are the inclination and curvature of the streamline, and this gradient is directed

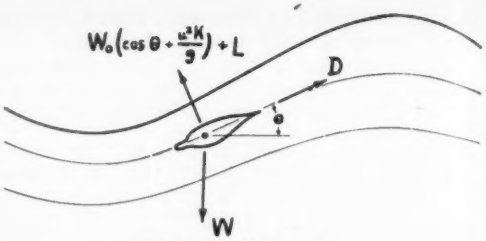

Fig. 1. Dolphin in a wave

normal to the streamline. This buoyant force is opposed by the force $W \cos\theta - L$ (see Fig. 1), where W is the total weight of the immersed body and L is the hydrodynamic lift. This gives the relation:

$$L + \frac{W_0}{g} u^2K = (W - W_0) \cos\theta, \qquad (1)$$

where W_0 is the weight of the displaced fluid, the hydrostatic buoyant force on the body. Balance of forces in the direction of the streamline gives:

$$D = W \sin\theta, \qquad (2)$$

where D is the hydrodynamic drag. For a wave rider planing on the surface, the equations would be the same but with $W_0 = 0$. The force opposing the hydrodynamic drag is independent of any buoyant force, which only affects the amount of hydrodynamic lift needed. Thus it is the total weight which is significant, and not the excess weight. The totally immersed dolphin may be at a slight disadvantage over a surface wave rider because the maximum value of θ is less below the surface than on the surface. However, the dolphin is at a significant advantage because it has very much less hydrodynamic wave drag and drag due to lift.

An alternative method of calculating the forces in this case would be to separate mathematically the effect of the gravitational field. From this point of view the drag force is opposed by a force equal to the displaced mass of fluid times the space derivative $u\,du/ds$ of $\frac{1}{2}u^2$ along the streamline, in addition to a force $(W - W_0) \sin\theta$. In view of the relation $g \sin\theta = u\,du/ds$, the two approaches may be seen to be equivalent. A third equivalent point of view is that an immersed body with no excess weight would be acted upon by a force which would give it the same acceleration as the fluid in the same vicinity.

For fore-and-aft stability the dolphin must be in a part of the wave for which K is positive, and it may be expected that this is normally the case. The hydrodynamic lift is thus generally somewhat less than $(W - W_0) \cos\theta$ and may be zero or of either sign.

In any event, the practical difficulty discussed by Woodcock and McBride, the difficulty of having to assume laminar flow, disappears. Added significance is given to their remark that this wave-riding force should be taken into account in any estimate of the dolphin's capacity for sustained work. With moderate velocities and reasonably large wave inclinations, the dolphin has amply sufficient thrust from this source to overcome drag with turbulent flow.

The opinions contained in this communication are the private ones of the writer and do not necessarily reflect the views of the United States Navy.

W. D. Hayes

Office of Naval Research,
U.S. Embassy, London. Aug. 14.

[1] Woodcock, A. H., *Nature*, **161**, 602 (1948). Woodcock, A. H., and McBride, A. F., *J. Exp. Biol.*, **28**, 215 (1951).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, December 7

POSTGRADUATE MEDICAL SCHOOL OF LONDON (at Ducane Road, Shepherd's Bush, London, W.12), at 4 p.m.—Prof. A. Haddow: "Recent Trends in the Experimental Pathology of Cancer".

UNIVERSITY COLLEGE, LONDON, DEPARTMENT OF BIOCHEMISTRY (in the Physiology Theatre, Gower Street, London, W.C.1), at 4.45 p.m.—Dr. H. Gutfreund: "Molecular Forces in Protein Solutions" (1). (Further Lecture on December 14.)*

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. J. B. S. Haldane, F.R.S.: "Communication Between Animals".

COMMUNICATIONS RESEARCH CENTRE (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. R. Wittkower: "Interpretation of Visual Symbols".*

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "The Ridley Report".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.45 p.m.—Prof. W. J. Pugh, F.R.S.: "The Geological Map of Great Britain" (Ramsden Memorial Lecture).

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY, in the Chemical Society's Rooms, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. R. F. Goldstein: "Ten Years Hence: the Promise of Chemical Technology in Great Britain".

Tuesday, December 8

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. H. E. M. Barlow: "Telecommunication: the Achievements of the Past and the Hopes for the Future".*

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

PHYSICAL SOCIETY, ACOUSTICS GROUP (at the Science Museum, South Kensington, London, S.W.7), at 5.15 p.m.—Prof. R. J. Pumphrey and Mr. I. A. Tumarkin: "Theory of Hearing".

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. J. H. Hastings: "Problems of Biochemical Engineering".

INSTITUTION OF MECHANICAL ENGINEERS, AUTOMOBILE DIVISION (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. P. P. Love, Mr. P. G. Forrester and Mr. A. E. Burke: "Function of Materials in Bearing Operation".

INSTITUTION OF THE RUBBER INDUSTRY, LONDON SECTION (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. E. P. B. Edwards: "Cyclised Rubber"; at 7 p.m.—Mr. F. R. Horridge: "Collection, Grading and Packing of Rubber in Malaya".

ROYAL SOCIETY OF MEDICINE, EXPERIMENTAL MEDICINE AND THERAPEUTICS SECTIONS (at 1 Wimpole Street, London, W.1), at 5.30 p.m.—Prof. J. H. Gaddum: "Clinical Pharmacology" (W. E. Dixon Lecture).

UNIVERSITY OF LONDON (in the Anatomy Lecture Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. Otto Koehler: "Thinking Without Words".*

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2) at 5.30 p.m.—Prof. L. Størmer (Oslo): "The Trilobitomorpha" ("Trilobites and Merostomes, an Old Arthropod Stock," 1).* (Further Lectures on December 9 and 11.)

ROYAL INSTITUTE OF CHEMISTRY (joint meeting with the SIR JOHN CASS COLLEGE CHEMICAL SOCIETY, at the Sir John Cass College, Jewry Street, London, E.C.3), at 6 p.m.—Dr. E. Lester Smith: "The Manufacture of Antibiotics".

Wednesday, December 9

PHYSICAL SOCIETY, COLOUR GROUP (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2), at 2.30 p.m.—Symposium on "The Colour-Rendering Properties of Fluorescent Lamps".

ROYAL SANITARY INSTITUTE (at 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Discussion on "Investigations into Detergency in Kitchens and Laundries".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. E. G. Woodroofe: "The Seed Crushing Industry".

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Symposium on "Vibration Methods of Testing".

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (joint meeting with the LONDON SECTION of the OIL AND COLOUR CHEMISTS ASSOCIATION, in the Lecture Theatre of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. J. E. O. Mayne and Mr. D. Van Rooyen: "The Mechanism of the Inhibition of Corrosion by Paints, with special reference to the action of Basic Pigments"; Mr. D. M. Brasher, Mr. A. H. Kingsbury and Mr. F. Wormwell: "Electrical Measurements in the Study of Paint Coatings on Metal".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP—NUTRITION PANEL (in the Rooms of the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 6.30 p.m.—Dr. R. Passmore: "Some Recent Investigations of Human Calorie Requirements" (Nutritional Reappraisals—2).

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, POLAROGRAPHIC DISCUSSION PANEL of the PHYSICAL METHODS GROUP (at the Sir John Cass College, Jewry Street, London, E.C.3), at 6.45 p.m.—Annual General Meeting, followed by Mr. D. J. Ferrett: "Studies with the Rotating Platinum Cathode"; Mr. G. F. Reynolds and Mr. H. I. Shalgosky: "The Polarographic Determination of Indium in Zinc and Zinc-Base Alloys".

Thursday, December 10

PHYSICAL SOCIETY, OPTICAL GROUP (at the Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Mr. G. E. Manville, Mr. M. G. L. Curties and Mr. H. W. Yates: Papers on "The Construction of Optical Elements".

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at the Smithfield Show and Agricultural Machinery Exhibition, Richmond Hall, Earls Court, London, S.W.5), at 3 p.m.—Dr. G. W. Cooke: "Designs of Fertilizer Distributors and their Mechanisms".*

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Francis Walshe, F.R.S.: "The Contribution of Clinical Observation to Cerebral Physiology" (The Ferrier Lecture).

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. J. F. Grandy: "The Development of the St. Lawrence Waterway" (Neil Matheson McWharrie Lecture).

PHYSICAL SOCIETY, LOW TEMPERATURE GROUP (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Eighth Annual General Meeting; 5.30 p.m.—Mr. A. G. Mackie: "The Performance and Operation of Low Temperature Rectifying Columns".

SIR THOMAS MIDDLETON MEMORIAL TRUST (in the Beveridge Hall, University of London, Senate House, London, W.C.1), at 5.30 p.m.—Prof. Sir James Scott Watson: "The State and Agriculture" (First Middleton Memorial Lecture).*

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Dr. Henry Foy: "The Influence of the Intestinal Flora on the Synthesis of Hæmopoietic Factors in the Megaloblastic Anæmia of Africans".

BRITISH SOCIOLOGICAL ASSOCIATION (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 8 p.m.—Mr. Ritchie Calder: "East Meets West".

Friday, December 11

ASSOCIATION OF APPLIED BIOLOGISTS (in the Mining Lecture Theatre, Imperial College, Prince Consort Road, London, S.W.7), at 11 a.m.—Scientific Papers.

BRITISH SOCIETY OF RHEOLOGY (at the Institute of Physics, 47 Belgrave Square, London, S.W.1), at 2 p.m.—Symposium on "Methods of Presenting Rheological Results and Their Relations".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, BIOLOGICAL METHODS GROUP (joint meeting with the PHARMACEUTICAL SOCIETY, in the Anatomy Lecture Theatre, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Symposium on "The Assay and Detection of Pyrogens".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—"Practical Training in Industry for the Graduate in Mechanical Engineering": four short papers by Mr. K. R. Evans, Mr. H. W. Fulton, Mr. R. S. Medlock and Prof. J. A. Pope.

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Dr. C. I. Bliss (U.S.A.): "Determinations of Drug Potency in Man".*

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. Ralph W. G. Wyckoff, For.Mem.R.S.: "The Electron Microscope in Biology".

Saturday, December 12

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, The London Hospital Medical College, Turner Street, London, E.1), at 11 a.m.—Scientific Papers.

BRITISH MYCOLOGICAL SOCIETY (at the Linnean Society of London, Burlington House, Piccadilly, London, W.1), at 12 noon—Annual General Meeting; 2.30 p.m.—Prof. C. T. Ingold: "Fungi and Water".

BRITISH PSYCHOLOGICAL SOCIETY (in the Psychology Department, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Dr. W. D. Neff: "Neural Mechanisms of Auditory Discrimination".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PHYSICIST (with degree or equivalent qualification, and preferably with research and/or industrial experience) for work which is concerned with various aspects of the manufacture and properties of knitted products—The Secretary, Hosiery and Allied Trades Research Association, 4 First Avenue, Sherwood Rise, Nottingham (December 12).

LECTURER (with degree in electrical engineering and able to teach up to final degree standard) IN ELECTRICAL ENGINEERING—The Principal, Wigan and District Mining and Technical College, Wigan (December 14).

ANALYST (with degree or equivalent qualification in chemistry, and preferably with some knowledge or interest in agriculture) to undertake and supervise routine soil and crop analyses—The Secretary, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen (December 18).

LECTURER (with experience in industry and some knowledge of electrical measurements, servomechanisms and electronics) IN THE DEPARTMENT OF ELECTRICAL ENGINEERING, University of Adelaide—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Adelaide, December 21).

ASSISTANT KEEPERS (2), at the Science Museum, South Kensington, S.W.7, (*a*) (with first- or second-class honours degree in engineering or aeronautical science) IN THE DEPARTMENT OF AERONAUTICS AND SAILING SHIPS; (*b*) (with first- or second-class honours degree in electrical engineering) IN THE DEPARTMENT OF ELECTRICAL ENGINEERING AND COMMUNICATIONS—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.134/54 (December 23).

CHEMIST (with honours degree in chemistry or A.R.I.C.) at Northern Outfall Works, Beckton, London, E.6—The Medical Officer of Health (PH/D.1), The County Hall, London, S.E.1 (December 28).

SCIENTISTS (with first- or second-class honours degree or equivalent qualification in physics or engineering, and some postgraduate experience in either light engineering, pneumatic and/or hydraulic mechanism design, design of light electrical, electronic or optical mechanisms) at the National Coal Board Central Research Establishment, Isleworth, Middlesex, to work in a group studying methods of establishing suitable instrumentation for use in mines and to design and improve instruments required for use in all aspects of mining and research into mining techniques—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/709 (December 28).

LECTURER IN BIOCHEMISTRY at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (December 31).

PRINCIPAL or SENIOR SCIENTIFIC OFFICER (with good honours degree in geography or equivalent) for physiographical and complementary ecological investigations in Great Britain, including work on problems of coast erosion and accretion; SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with good honours degree in botany, agriculture or equivalent) to take charge of the Nature Conservancy Field Station, Moor House Nature Reserve, Alston; SCIENTIFIC OFFICER (with good honours degree in zoology, and preferably interested in small mammals) to assist with field studies and surveys of mammals in relation to the ecology of woodlands, at the Nature Conservancy Research Station, Grange-over-Sands, Lancashire—The Establishment Officer, The Nature Conservancy, 91 Victoria Street, London, S.W.1 (December 31).

PROFESSOR OF PHYSIOLOGY, PROFESSOR OF ZOOLOGY, and a LECTURER IN EXPERIMENTAL PHYSICS—The Secretary, University College, Cork, Ireland (January 4).

IMPERIAL CHEMICAL INDUSTRIES FELLOWSHIP, tenable at Durham or Newcastle, for research in chemistry, physics and allied subjects, including the biological application of chemistry—The Registrar, University Office, 46 North Bailey, Durham (January 9).

TURNER AND NEWALL FELLOWSHIP, tenable at Durham or Newcastle, for research in engineering, inorganic chemistry or physics, or in an allied science, if approval for the purpose of such an award is obtained—The Registrar, University Office, 46 North Bailey, Durham (January 9).

SENIOR LECTURER IN APPLIED AND INDUSTRIAL CHEMISTRY, a LECTURER IN CIVIL ENGINEERING, a LECTURER IN CHEMISTRY, and LECTURERS (2) IN PHYSIOLOGY, at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Cape Town, January 25).

LECTURER or ASSISTANT PROFESSOR OF ZOOLOGY—The Dean, Faculty of Arts and Science, University of Alberta, Edmonton, Canada (February 1).

ASSISTANT LECTURER (Grade B) IN PHYSICS—The Principal, Royal Technical College, Salford.

BIOCHEMIST (Senior grade) for duties in the Department of Clinical Pathology—The Group Secretary, Stafford Hospital Management Committee, 13 Foregate Street, Stafford.

CHEMICAL ENGINEER or APPLIED CHEMIST (preferably with industrial experience) required for a new Industrial Advisory Service—The Coal Tar Research Association, Oxford Road, Gomersal, Leeds.

LECTURER or ASSISTANT LECTURER IN ANIMAL PHYSIOLOGY in the Department of Zoology—The Secretary and Registrar, The University, Southampton.

LECTURER or ASSISTANT PROFESSOR OF APPLIED MATHEMATICS—Prof. I. R. Pounder, Department of Mathematics, University of Toronto, Toronto, Canada.

RESEARCH ASSISTANT (with a degree in engineering or physics) at the National College for Heating, Ventilating, Refrigeration and Fan Engineering, to carry out research on heat transfer, refrigeration or aerodynamics—The Clerk to the Governors, Borough Polytechnic, Borough Road, London, S.E.1.

REPORTS and other PUBLICATIONS

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Colonial Office. Blister Blight Disease of Tea (*Exobasidium Vexans* Massee). By Dr. T. Eden. Pp. ii+5+2 plates. (London: H.M. Stationery Office, 1953.) 9*d*. net. [110

British Internal Combustion Engine Research Association. Tenth Annual Report, 1st April, 1952–31st March, 1953. Pp. 18. (Slough: British Internal Combustion Engine Research Association, 1953.) [110

Air Ministry: Meteorological Office. Geophysical Memoirs No. 90: Seasonal Change of Surface Temperature of the North Atlantic Ocean. By T. H. Kirk. Pp. 36. (London: H.M. Stationery Office, 1953.) 5*s*. 6*d*. net. [110

Ion Exchange Resins. Second enlarged edition. Pp. 36. (Poole: British Drug Houses, Ltd., 1953.) [510

Building Research Station Digest No. 58: Wall and Ceiling Surfaces and Condensation. Pp. 4. (London: H.M. Stationery Office, 1953.) 3*d*. net. [510

University of London. University College Calendar 1953–54. Pp. lxiv+472. (London: University College, 1953.) [510

City of Leeds. Annual Report of the Sub-Libraries and Arts (Museums) Committee to the Council for the Year ended 31st March, 1953. Pp. 10. (Leeds: City Museums, 1953.) [810

Ministry of Agriculture and Fisheries. Fishery Investigations, Series 1, Vol. 5, No. 6: Salmon Studies. By Dr. J. W. Jones. Pp. 16. (London: H.M. Stationery Office, 1953.) 1*s*. 6*d*. net. [810

The National Central Library. 37th Annual Report of the Executive Committee for the Year ending 28 February, 1953. Pp. 30. (London: National Central Library, 1953.) [910

Other Countries

Scientific Council for Africa South of the Sahara. Maps of Africa South of the Sahara. (Publication No. 4.) Pp. ii+122. (Bukavu, Belgian Congo: Scientific Council for Africa South of the Sahara, 1953.) 18 francs. [110

Uganda Protectorate. Annual Report of the Forest Department for the Year ended 31st December, 1952. Pp. ii+38. (Entebbe: Government Printer, 1953.) 1/75 Shs. [110

World Health Organization. Technical Report Series No. 73: Expert Committee on Mental Health, Third Report. Pp. 38. (Geneva: World Health Organization; London: H.M. Stationery Office, 1953.) 2*s*.; 0.25 dollars; 80 French francs; 1 Swiss franc. [110

Annual Report of Scientific Works from the Faculty of Science, Osaka University. Volume 1 for 1952. Pp. ii+122. (Osaka: Faculty of Science, Osaka University, 1953.) [110

Astronomical Papers prepared for the use of the American Ephemeris and Nautical Almanac. Vol. 13, Part 3: Catalog of 5,268 Standard Stars, 1950.0. Based on the Normal System N30. By H. R. Morgan. Pp. xxviii+109–321. (Washington: Government Printing Office, 1952.) 2.25 dollars. [110

Companhia de Diamantes de Angola. Servicos Culturais. Museu do Dundo: Subsidios Para a História, Arqueologia e Etnografia dos Povos da Lunda. Paredes Pintadas da Lunda. Por José Redinha. (Publicações Culturais No. 18.) Pp. 32+55 plates. (Lisboa: Companhia de Diamantes de Angola, 1953.) n.p. [110

Smithsonian Miscellaneous Collections. Vol. 122, No. 6: The External Morphology of the Dragonfly *Onychogomphus Ardua* Needham. By Hsiu-Fu Chao. (Publication No. 4137.) Pp. ii+56. (Washington: Smithsonian Institution, 1953.) [510

University of Helsinki, Institute of Meteorology. Paper No. 72: The Aerological Atlantic Expedition of the Finnish Academy of Sciences. Part 3: Some Results from the Finnish Atlantic Expedition 1939. By Lauri A. Vuorela. Pp. 20. (Helsinki: University of Helsinki: Institute of Meteorology, 1953.) [510

Forest Research Institute, Dehra Dun. Indian Forest Leaflet No. 133: (Wood Preservation), Treatment Against Decay and Fire of Grasses and Palmyra Leaves Used in Thatching Roofs. By A. Purushotham and K. S. Rana. Pp. 5. (Delhi: Manager of Publications, 1953.) –/5/– annas; 6*d*. [510

Scientific Institutions and Scientists in Latin America. Uruguay. Vol. 2. Pp. x+259. (Montevideo: Unesco; Science Co-operation Office for Latin America, 1953.) [510

World Directory of Medical Schools. Pp. 220. (Geneva: World Health Organization; London: H.M. Stationery Office, 1953.) 25*s*.; 4 dollars; 1,200 French francs; 15 Swiss francs. [810

Metropolitan Life Insurance Company. Statistical Bulletin, Vol. 34, No. 8: Health of Teen-Agers. Pp. 12. (New York: Metropolitan Life Insurance Company, 1953.) [810

Scientific and Technical Journals of East and South East Asia (Hong Kong, Japan, Indonesia, Macao, Malaya, North Borneo, The Philippines, Sarawak, Thailand, Vietnam). Second edition. Pp. viii+233. (Manila: Unesco (South East Asia Science Co-operation Office, 1953).) [810

Some Conjugated Proteins: a Symposium. (Six Lectures presented at the Ninth Annual Conference on Protein Metabolism. Bureau of Biological Research, Rutgers University, the State University of New Jersey, January 30–31, 1953. Edited by William H. Cole. Pp. ix+73. (New Brunswick, N.J.: Rutgers University, 1953.) 1.75 dollars. [810

Transactions of the American Philosophical Society. New Series—Vol. 43, Part 2: Encyclopedic Dictionary of Roman Law. By Adolf Berger. Pp. ii+333–808. (Philadelphia: American Philosophical Society, 1953.) 5 dollars. [810

Catalogues

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Publication No. 550: Particle Size Determination Apparatus. Pp. 4. (London: A. Gallenkamp and Co., Ltd., 1953.)

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